Pain Taxonomy – Classifying Needle Inflicted Pain Sensation

by

Jenani Jayavalan

Dissertation submitted in partial fulfillment of
the requirement for the
Bachelor of Technology (Hons)
(Information Technology)

December 2011

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CERTIFICATION OF APPROVAL

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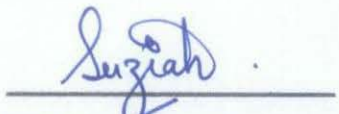
Approved by,



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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

JENANI JAYAVALAN

ABSTRACT

Acupuncture is an interesting area in traditional healing. It has proven to be effective in healing many types of ailments. Namely pain related ailments like headache, flu and minor back pains. Acupuncture has also managed to heal certain cases that couldn't be healed by modern medicine like cancer and stroke in some patients. Ironically, many patients are greatly phobic of treatments that involve piercing of needles. Mainly because of the pain inflicted. So they tend to hinder taking the treatment even when they really need it.

The motivation of this study is to help reduce phobia towards needle inflicted pain sensation using haptic technology. The study proposes a taxonomy to classify needle inflicted pain sensation in the haptic domain. The objectives are to eliminated vagueness of describing pain sensation.

Also in further views, the study is seen to be futuristic as it is the stepping stone to research in the area of pain related phobia reduction in both haptic and virtual reality sector. Having established a taxonomy to classify needle inflicted pain sensation will help in being the baseline to build future systems in Virtual Reality and touch solutions to reduce pain related phobia.

It will also greatly help the acupuncture field to gain client's confidence as vagueness of describing pain sensation will be eliminated.

ACKNOWLEDGEMENT

It is a pleasure to thank those who made this thesis possible. Many people have assisted me through the whole process of developing this project. I would like to first thank God for his blessing in completing my final year project.

I am heartily thankful to my supervisor, Dr Suziah Sulaiman for her full support, encouragement and supervision from the preliminary to the concluding level of my project. It would have been next to impossible to write this thesis without her help and assistance.

I also would like to make a special reference to DR SS Jayabalan, the Acupuncture Doctor of the clinic who helped me with this project. My gratitude also goes to my beloved family who gave me the moral support I required. Lastly, I offer my regards to my friends and all of those who have directly or indirectly encouraged me in any aspect in concluding this project.

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Chapter 1

Introduction

1.1 Project Background

The key component of this project is pain. When we talk about pain, we have to associate it with senses, which are the physiological capacities of organisms that provide inputs for perception. An organism naturally has 5 senses which include sight, hearing, taste, smell and touch. Apart from these, there are also additional senses which are temperature, kinaesthetic sense, pain, balance and acceleration. Pain is defined as an unpleasant feeling that is conveyed to the brain by sensory neurons [1]. The discomfort pain triggers indicates actual or potential injury. Pain also acts as a defence mechanism for instance, when a child touches a pot that has been heating in the stove, he feels pain and automatically his motor capability tells him to take his hand away. This reduces the occurrence of a severe burn on the child's hand. With that overview of pain, we move into this project's view of pain. Here, we are relating pain to the haptic feedback people have on the idea of acupuncture. Acupuncture is an alternative medicine that treats patients by insertion and manipulation of needles in the body. The advocates of acupuncture variously claim that the practice relieves pain, treats infertility, treats disease, prevents disease, or promotes general health. The main benefit of acupuncture is that it treats pain [2]. From headaches, migraines, back aches and so on, acupuncture is said to have a great level of impact in reducing the amount of pain by treating the imbalance in the body's Qi, through insertion of needles [3]. Yet no matter how effective acupuncture has proven to be, the very idea of having needles inserted into one's body created the fear of phobia of pain induced by it. Furthermore, the area of reducing phobia using computer haptics and virtual reality is fairly an attractive area of study at the present. However, it is evident that the researches are lacking in the area of pain related phobia reduction. This gives an opening to a new area of research in haptics, if we can construct

taxonomy of needle inflicted pain, we could possibly reduce the phobia of people towards the very idea of acupuncture.

Therefore, this project proposes a study of needle inflicted pain sensation. The outcome of the study would be taxonomy of needle inflicted pain sensation. Various studies will be carried out on how people describe the sensation of pain and how actual acupuncture patients describe the pain sensation in the treatment. A suitable classification method is then made to classify the degree of pain inflicted during an acupuncture treatment. After which, the findings are validated and a taxonomy is generated.

1.2 Problem Statement

1.2.1 Problem Identification

There are several problems identified the practice of acupuncture

1.2.1.1 Existence of phobia towards needles

Generally people fear needles or any kind of sharp object that can pierce or cut [4]. Not only in acupuncture but also in modern medicine, people are afraid of syringes, needles and the sort. The fear of needles acts as a barrier to undergo such treatments though may help in reducing ailments.

1.2.1.2 Vague description of pain

Currently, there is very limited research on describing the degree of pain especially in the area of acupuncture. When a patient comes to the clinic, there is great amount of anxiousness as they don't know what to expect. This leads the patient being tensed. An acupuncture treatment requires the patient to be

relaxed during the process and they are obviously not due to the anxiety.

1.2.1.3 Self assumed degree of pain

Most of the time, patients have their own assumption on the degree of pain which the treatment is going to inflict. Many times it can be more than the actual degree is. This can avoid the patient from taking the treatment and also can induce fear towards the treatment itself.

1.2.1.4 The sensation of pain have not been classified

At the present time, there are not studies that have actually classified needle inflicted pain [5]. Not having a proper classification of needle inflicted pain makes the sensation description vague for researchers in the topic of pain in haptics, especially needle inflicted pain. Constructing a taxonomy that clearly classifies the various sensation of needle inflicted pain will assist in future studies and help in being a base-line to build systems in relation to pain [6].

1.2.2 Significance of the Project

The significance of this project is to function as a central technology in describing the degree of pain in the practice of acupuncture. The taxonomy also would contribute greatly to the treatment's effectiveness and gain competitive advantage as phobia towards pain inflicted by needles will be reduced.

1.3 Objectives

The objectives of this project are:

1. To identify ways of classifying pain sensation.
2. To construct taxonomy of how people describe pain sensation.
3. To validate the taxonomy.

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1.4 Scope of Study and Limitations

The project focuses on creating a system to assist the practice of acupuncture on simulating the degree of pain. The primary focus is to simulate the degree of pain inflicted by the various sizes of needles and on various points of the body using different pressure levels. The degree of pain is measured using the Minsky's classification of sensation [7]. Therefore, the study will be on how people describe pain and it will be carried out through a series of interviews on acupuncture patients. Following the interview results will be gathered to classify the sensation and a system will be developed to simulate the degree of pain. However, the limitation of this project is the use of needles in the simulation. For safety purposes, I can't use real needles in simulating the degree of pain. Hence as an alternative, I will simulate it through the rising of the braille line point. Other than that, pain itself is something that is intangible. It is something quite hard to quantify.

1.5 The Relevancy of the Project

A proposed project should always have a stand to benefit, worthwhile and necessary. Besides that, a proposed solution should project its primary value as the solution for an identified problem. In this case, relevancy is determined by three evaluation criteria which are potential organizational benefits, strategic fit, and level of resource allocation. Potential organizational benefits can be defined as the degree to which the proposed project will beneficial to an organization or for the people around us [8]. The taxonomy constructed certainly would help eliminate vagueness of pain sensation in an acupuncture treatment. This will in hand improve the patient's confidence in the treatment due the reduction of phobia. This proposed taxonomy will also make describing pain much simple and straightforward compared to just describing through words. Apart from that, the study would be a base-line for further research and also developments of systems related to reduction of phobia towards pain. Viewing it from the strategic fit point, it of course satisfies the criteria as the proposed technology serves best its purpose in the line of pain related phobia reduction and the study is not costly. Thus it will help the acupuncture industry in terms of customer satisfaction due to improved reliability as a result of reduction of fear towards needle inflicted pain sensation.

1.6 Feasibility of the Project within the Scope and Time Frame

The assessment of project feasibility is an activity that occurs several times throughout the development cycle. The time frame for this project is divided into two parts. The first 5 months of the project will focus on research base activities and the deliverables will be the research results. Meanwhile, the second half of the time frame will focus on validating the constructed taxonomy. The research and information uncovered by the study conducted will support the detailed construction of the final taxonomy. Given the technical expertise and project deadlines, the schedule feasibility of this project is positively reasonable and achievable.

CHAPTER 2

LITERATURE REVIEW

Pain is defined as unpleasant sensory and emotional experience associated with actual or potential tissue damage [9]. Pain is nature's way of telling the brain about injury to the body. Viewing from the biological context, the purpose of pain to the human body system can be categorized to the main points, which are, as a warning of threat to the body, as a basis of learning and it forces a person to rest. Pain serves as a warning to potential threat for instance in the scenario of touching a boiling kettle, the nervous systems perceives the heat as an unpleasant sensation that causes pain and makes the person take away his hand. In terms of learning, the same person will avoid touching a boiling kettle in future, unless accidentally. And when the body knows that it is being over worked, it will tend to generate the feel of being beat up and in turn makes the person perceive the feeling of pain through aches and sores throughout the body, which forces a person to rest.

When we talk about pain, it is only appropriate to look into some of the main terms in the human nervous system which dictates the pain sensory mechanism. The aspects that will be discussed are:

- Nerves
- Nerve Cells
- Pain Receptors
- Synapse
- Spinal Cord
- Brain

- Acute Pain
- Chronic Pain
- Inflammatory Pain

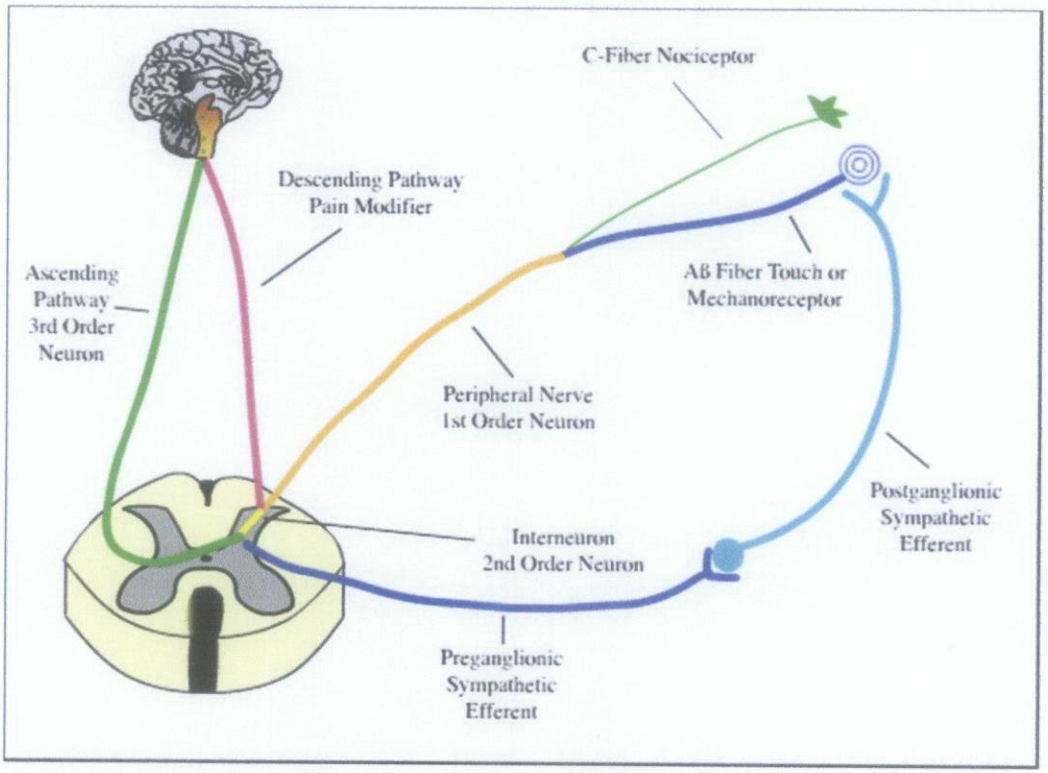


Figure 1: The human nervous system

Nerves

Nerves are actually made up of many of the axons of individual nerve cells running together towards the spinal cord to enter into the central nervous system. Pain nerves mix with position sense nerves, temperature sense nerves, vibratory sense nerves, and muscle control nerves [10]. These nerves become larger and are made up of more axons as they move closer to the spinal cord. Just before they reach the spinal cord the nerves form a nerve root, which splits into a front and back part (Dorsal Root). The part that goes to the back of the spinal cord carries the pain signal to the spinal cord (Dorsal Horn of the Spinal Cord). From here it is passed from a relatively short nerve

(Interneuron) to the nerve tract that runs to the brain (Spinothalamic Tract). When it reaches the brain it is passed to other nerve cells that carry it over to the thinking (Cerebrum) and emotional (Limbic System) centres of the brain.

Nerve Cells

The nerve cell consists of a cell body, dendrites and a long axon. Many nerve cells make up any single nerve. They are organized in clumps of cell body's called ganglia with axons running together for the length of the nerve. They end in axon terminals that interface with cell body dendrites. There actually is no physical connection and the space between the axon terminals and the cell body dendrites is called a synapse. Nerve signals are sent across the synapse in a process that converts an electrical signal traveling down the axon to a chemical transmitter and back to an electrical signal on the other side of the synapse. This occurs in 3/1000th's to 90/1000th's of a second, with tens of thousands of cells firing at any one time [11].

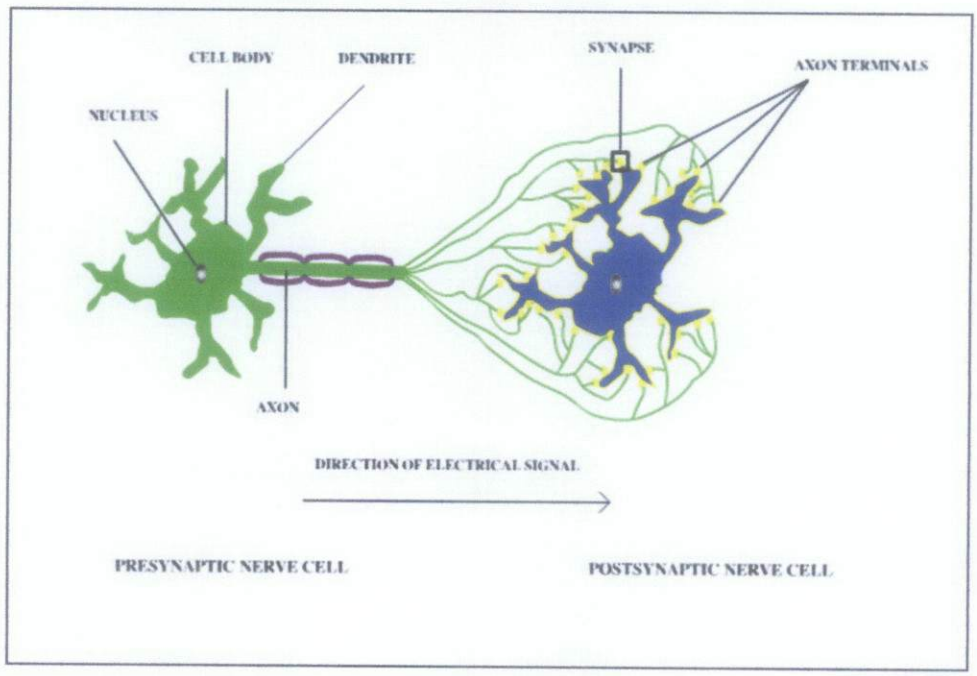


Figure 2: Illustration of a nerve cell

Pain receptors

Pain receptors are specialized nerve endings located throughout the body in most body tissues. They transmit pain from injury, disease, movement or environmental stress [12]. These specialized nerve endings are stimulated by release of pain producing chemicals that arise from local blood vessels, connective tissue cells called fibroblasts and specialized blood cells in the tissues called macrophages. Once the nerve endings are stimulated by these chemicals they begin firing the nerves that are connected to them and send pain signals to the spinal cord and brain.

Synapse

The synapse is the gap between the nerve axon terminals heading towards the spinal cord and the next nerve cells in the signal chain. In the case of pain these nerves synapse in the back part of the spinal cord called the Dorsal horn. Nerves convert electrical energy into chemical energy and back to electrical energy [13]. This is the way all nerve cells in the body work. This animation shows a synapse enlarged many times to illustrate the presynaptic cell, synapse and postsynaptic cell.

Spinal Cord

With rare exception nerve impulses from the body all must come into the spinal cord. Here the nerves synapse with spinal nerves that form tracts that run to the brain. Where pain is concerned, these tracts run through the spine to the part of the brain known as the Thalamus [14]. The Dorsal Horn is the part of the spinal cord that receives painful nerve impulses. Here nerve axon terminals synapse with nerve cell bodies. It is here where the battle against chronic pain begins. If this part of the nervous system fails, pain can be greatly increased and difficult to bring under control.

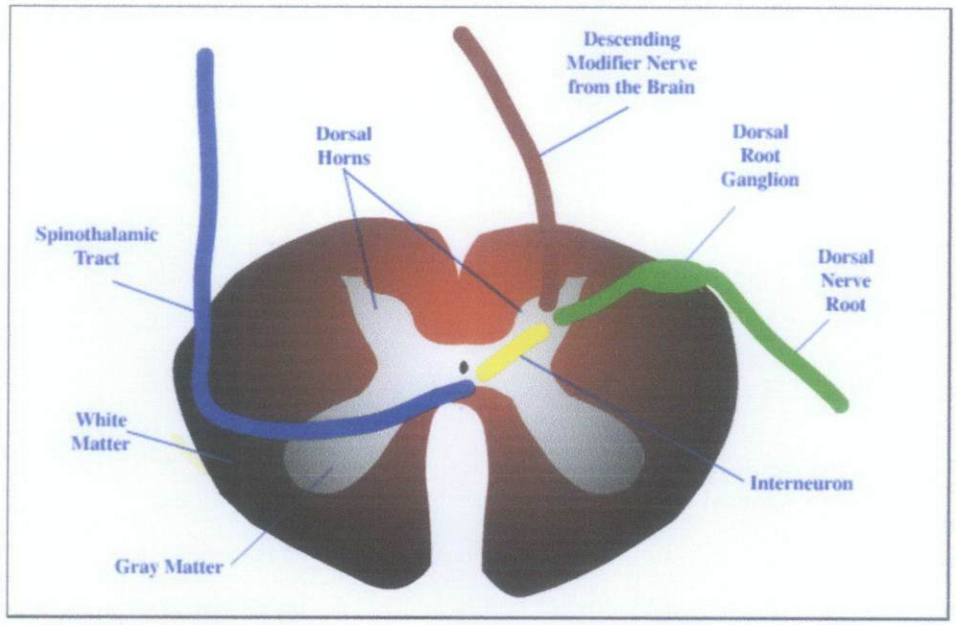


Figure 3: Illustration of the spinal cord

Brain

When pain signals arrive at the brain, they are distributed to multiple regions, including the medulla, cerebellum, pons, limbic system and somatosensory cortex [15]. At the same time the brain is also modulating incoming pain signals by sending down a countersignal from the cerebral cortex, diencephalon, midbrain, pons and medulla. These occur simultaneously in a symphony of neuronal activity.

Acute Pain

Acute pain travels into the spinal cord along the appropriate nerve root. The nerve root splits into a front division and a back division. Among other functions, the nerve root carries pain to the Central Nervous System (the spinal cord and brain). The pain signal is passed to a short tract of nerve cells (Interneurons), which in turn synapse with a nerve tract that runs to the brain. From there it is sent out to the rest of the brain, connecting with thinking and emotional centres. A Modifier Pathway from the brain modifies pain at the synapses in the back part of the spinal cord [16]. It is partially for this reason that acute pain is decreased rapidly after tissue injury.

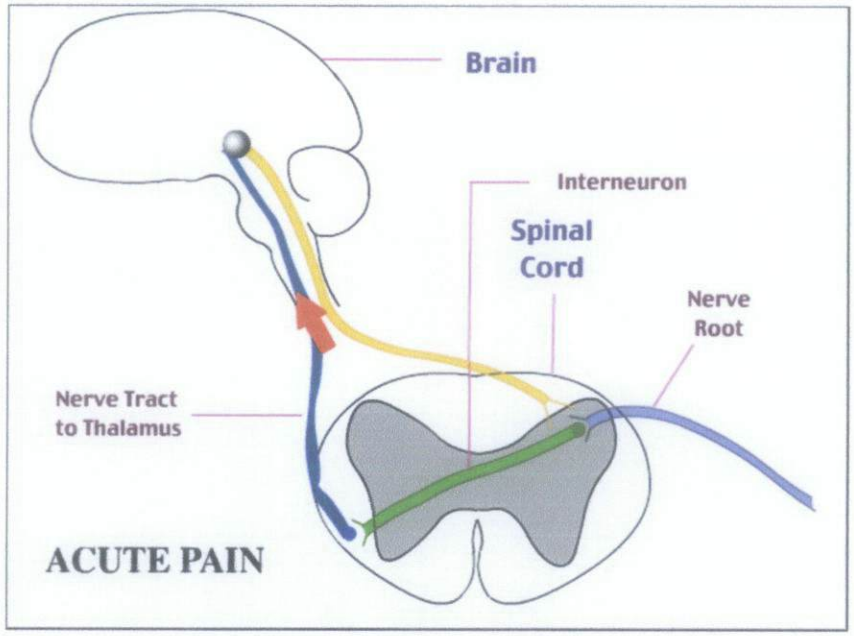


Figure 4: Illustration of acute pain occurrence

Chronic Pain

Chronic pain occurs when the back part of the Spinal Cord has been bombarded by severe pain for a long period of time. The Interneuron adjusts and transforms to the Wind-up Nerve by adding fast pain receptors that amplify the pain signal and pass the amplified signal to the nerve tract that runs up to the brain. From there the thinking and emotional centres of the brain receive a large pain signal and the mind perceives increasingly severe intractable pain. Modifier Pathways in the brain attempt to tone down the pain, but are defeated at the back part of the spinal cord by the Wind-up Nerve. The brain keeps receiving amplified pain signals and the mind continues to perceive unrelenting and severe pain.

Inflammatory Pain

Inflammatory pain causes the receptors in the inflamed tissue to transmit the pain signal to the nerve that supplies the affected area. The inflammatory response is a complicated local reaction, involving numerous body chemicals, blood vessel changes, temporary or permanent tissue damage and potential spread to other sites. This can be an acute process or it can become chronic.

All body structures in the inflamed area become inflamed themselves, including nerve endings. This can complicate the pain picture. In chronic inflammatory pain, the inflammatory chemicals have caused permanent damage to the chemical receptor and the nerve it feeds. This causes the same chemicals to damage touch receptors and nerves that normally do not transmit pain. This results in pain, even to light touch, and the consequence of increased pain at the Spinal Cord due to wind-up. In this case wind up occurs when normally non painful touch nerves begin to carry pain to the Central Nervous System.

Having looked into the wider context of pain, we narrow it down to the context in this study. Generally, there are two types of pain; fast (acute) and slow (chronic) pain. Under those categories there are different sensations of pain. For example:

- Fast (acute)
  - sharp
  - electric
  - pricking
- Slow (chronic)
  - burning
  - throbbing
  - aching

This study focuses on needle inflicted pain sensation which results from an acupuncture treatment. So the pain sensation involved is acute pain as acupuncture treatment involves piercing of needles that mainly gives the sharp or pricking sensation. Generally, people have a great level of phobia towards needle based treatments, be it vaccination, blood tests, drips and so on. The phobia itself hinders them from taking any treatment related to needle namely acupuncture. So the question here is how touch or haptics can help in reducing the phobia towards needle inflicted pain sensation. From extensive readings, it is found that the sensation of pain haven't especially needle inflicted pain hasn't been classified before. Needle inflicted pain sensation seems very

abstract and vague at the moment and needs further research so that it will be easy to describe it than merely using random words as a means of description. When there is a proper baseline for classification of needle inflicted pain sensation, it will be possible to reduce the fear of acupuncture treatment as a result of eliminating the vagueness of existing descriptions. From the above explanation of pain, the study will not take in context the area of inflammatory pain. Here we are saying that, the study conducted will be on patients with fairly a good condition of health state so that the finding won't clash with chronic pain (slow) and long term existing pain and of those inflamed and swollen body parts. We are not taking those in context as the practice of pierce needles inflict acute pain and that is the area in which we would like to research on.

So the area that we are highlighting here is how we can apply touch to assist in reducing fear towards needle inflicted pain which is mainly acute pain. And the best possible way is to first come up with taxonomy to classify the corresponding pain sensations before building systems that will help reduce pain related phobia.

With that said, we will next look into related works in describing pain.

Existing Methods in Describing Pain Sensation

The Brief Pain Inventory (BPI), based from a measure known as the Wisconsin Brief Pain Questionnaire, was developed by the Pain Research Group to provide information on the intensity of pain (the sensory dimension) as well as the degree to which pain interferes with function (the reactive dimension) [17]. The BPI also asks questions about pain relief, pain quality, and the patient's perception of the cause of pain.

The BPI uses 0 to 10 numeric rating scales (NRS) for item rating because of its simplicity, lack of ambiguity and seemed the best to use for cross-linguistic pain measurement. Since pain can be quite variable over a day, the BPI asks patients to rate their pain at the time of responding to the questionnaire (pain now), and also at its worst, least, and average over the previous week. The ratings can also be made for the last 24 hours. The design of the study will dictate the most appropriate period to rate. The pain worst rating can be chosen to be the primary response variable, with the other items serving as a check on variability, or, alternatively, these ratings can be combined to give a composite index of pain severity. While it is necessary to limit the dimensions of assessment, it is critical to estimate the degree to which pain limits patient function. Interference of function can be thought of as a reactive dimension. An effective intervention for pain control should demonstrate its effectiveness on more than a reduction in pain intensity alone. Again, using numeric 0 to 10 scales, with 0 being "no interference" and 10 being "interferes completely," the BPI asks for ratings of the degree to which pain interferes with mood, walking and other physical activity, work, social activity, relations with others, and sleep. The mean of these scores can be used as a pain interference score. The BPI has demonstrated respectable test-retest item correlations (reliability), at least over short intervals. Evidence for the validity of the BPI comes from several studies using the instrument with cancer patients and patients with other diseases who had pain. Expected differences in pain severity were found between groups of patients with pain who differed in the presence or absence of metastases. Ratings of pain interference with various activities increased as

ratings of pain severity were higher. The proportion of patients receiving opioid analgesics increased with increased severity rating. Finally, the correlations among the items differed in a logical way from one disease to another, suggesting that the BPI is sensitive to differences in pain characteristics associated with different diseases [18].

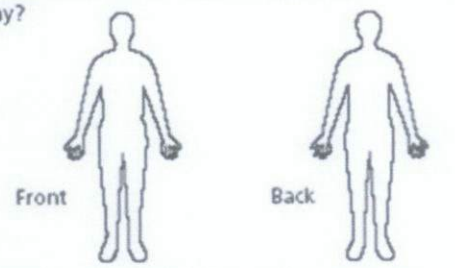
A unique feature of the BPI is that it has been validated in many languages such as Chinese, Filipino, French, Hindi, Italian, Spanish and Vietnamese, and has been shown to produce similar data from patients in these countries and from many different cultures. Finally, the BPI has several applications, including studies of the epidemiology of cancer pain, the routine clinical assessment of pain, efforts to assure the quality of pain management, and the conduct of clinical trials examining the effectiveness of cancer pain treatments.

In reference to this study, the BPI has a gap in the aspect of conceptual description of the sensation. The BPI helps measure the degree of pain using a 0 to 10 ratio in the aspects of interference to routine activities and also the degree of pain that is bearable or unbearable. But it lacks in the area of describing the properties of the pain itself like the use of representations. In this case prickly, stinging, poking, sharp and so on. This study will use some aspects of the BPI which is in context like the degree of pain but will add required properties such as conceptual description to enhance the effectiveness of the classification.

Brief Pain Inventory

Name Date Time

1. Throughout our lives, most of us have had pain from time to time (such as minor headaches, sprains, toothaches). Have you had pain other than these everyday types of pain today?
   1. Yes 2. No
2. On the diagram, shade in the areas where you feel pain. Put an X on the area that hurts the most.



3. Please rate your pain by circling the one number that best describes your pain at its worst in the past 24 hours.

   0 1 2 3 4 5 6 7 8 9 10
   No pain — *Pain as bad as you can imagine*

4. Please rate your pain by circling the one number that best describes your pain at its least in the last 24 hours.

   0 1 2 3 4 5 6 7 8 9 10
   No pain — *Pain as bad as you can imagine*

5. Please rate your pain by circling the one number that best describes your pain on average.

   0 1 2 3 4 5 6 7 8 9 10
   No pain — *Pain as bad as you can imagine*

6. Please rate your pain by circling the one number that tells how much pain you have right now.

   0 1 2 3 4 5 6 7 8 9 10
   No pain — *Pain as bad as you can imagine*

7. What treatment or medication are you receiving for the pain?

   _____

   _____

   _____

   _____

   _____

8. In the past 24 hours, how much relief have pain treatments or medication provided? Please circle the one percentage that most shows how much relief you have received.

   0% 10 20 30 40 50 60 70 80 90 100%
   No relief — *Complete relief*

9. Circle the one number that describes how, during the past 24 hours, pain has interfered with your:

   A. General activity

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   B. Mood

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   C. Walking ability

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   D. Normal work (includes both work outside the home and housework)

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   E. Relations with other people

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   F. Sleep

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   G. Enjoyment of life

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   H. Ability to concentrate

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

   I. Appetite

   0 1 2 3 4 5 6 7 8 9 10
   Does not interfere — *Completely interferes*

Figure 5: Brief Pain Inventory form [19]

Virtual Reality in Reducing Phobia

Virtual reality proves to be one of the best methods in reducing phobia. There have been many developments in this area as many are venturing into this field of research. Studies show that virtual-reality programs are more effective than ordinary video games in diverting patients from the often unbearable pain of wound care. Pain has a strong psychological component. The same incoming pain signal can be interpreted as more or less painful depending on what the patient is thinking. In addition to influencing the way patients interpret such signals, psychological factors can even impact the amount of pain signals allowed to enter the brain's cortex. Neurophysiologists Ronald Melzack and Patrick D. Wall developed the "gate control" theory of pain in the 1960s ["The Tragedy of Needless Pain," by Ronald Melzack; Scientific American, February 1990]. Introducing a distraction—for instance, by having the patient listen to music— has long been known to help reduce pain. As virtual reality is a distinctively effective new form of diversion, it makes an ideal tool for pain control.

Virtual Reality in the area of pain control

- One of the best ways to alleviate pain is to introduce a distraction. Because virtual reality immerses users in a three-dimensional computer-generated world, it is uniquely suited to distracting patients from their pain.
- Burn patients undergoing wound care report that their pain drops dramatically when they engage in virtual-reality programs. Functional magnetic resonance imaging shows that virtual reality actually reduces the amount of pain-related activity in the brain.
- Virtual-reality programs can also help phobic patients overcome their fear of spiders, heights, flying or public speaking. A specially designed program is now being used to treat post-traumatic stress disorder in survivors of the September 11 attacks.

Figure 6: Virtual Reality in practice

Burn patient participates in a virtual-reality program to let go the pain of his wound care at Harborview Burn Centre in Seattle. Wearing a headset and manipulating a joystick, the patient manoeuvres through the program called Snow World, which was specially designed to ease the pain of burn victims[20].

(a) (b) (c)

Scenario a,b and c depict a virtual reality program re-creating a bus bombing designed to treat post-traumatic stress disorder in survivors of terrorist attacks in Israel and Spain. By gradually exposing the survivors to realistic images and sounds of a bus bombing, the program helps them to process and eventually reduce the devastating emotions associated with the traumatic event [21].

Virtual Reality in Fighting Fear

Apart from that, another therapeutic application of virtual reality is combating phobias by exposing patients to graphic simulations of their greatest fears. This form of therapy was introduced in the 1990s by Barbara O. Rothbaum of Emory University and Larry F. Hodges, now at the University of North Carolina at Charlotte, for treating fear of heights, fear of flying in airplanes, fear of public speaking, and chronic post-traumatic stress disorder in Vietnam War veterans. Like the pain-control programs, exposure therapy helps to change the way people think, behave and interpret information.

Figure 7: Virtual Reality in practice

Spider World, a virtual-reality program designed to help phobic patients overcome their fear of spiders. The patient wears a headset that shows a virtual tarantula. To provide tactile feedback, the system tracks the positions of a toy spider and the patient's hand, allowing her to "touch" the virtual creature [22].

From analysing the existing works in virtual reality the findings are:

- Virtual reality focuses more on reduction of phobias like height, insects, fire, and claustrophobia and so on.
- In terms of pain phobia reduction, there have been developments, yet it focuses on distraction as a tool of pain control not simulation of the real cause of pain phobia to eliminate the pain related phobia.

With those findings, it can be said that there is room for improvement. Virtual reality can explore into the area of reduction of pain related phobia by simulating the actual cause of pain or the practice of stimulant of pain to those phobic towards that particular category of stimuli.
For that particular reason, it is first important to classify the sensation of pain, in this case, needle inflicted pain sensation. The motivation is that the taxonomy constructed will help in being the base-line for development of virtual reality systems that help reduce fear of pain especially needle inflicted pain that will benefit the acupuncture field.

Related Works on Haptic Visualization

In reviewing works on haptic visualization, it is important to understand the motion brought by Minsky. Minsky suggests that, people encountering certain stimulations have a wide ranging language of description and metaphor about the composition and nature of the experimented surfaces [23]. They qualitatively list the types of surfaces according to perceived surface features or textures. He advocates that, they mainly have three styles in their descriptive strategies.

They are:

- Physical/ Metric
- Perceptual
- Cognitive

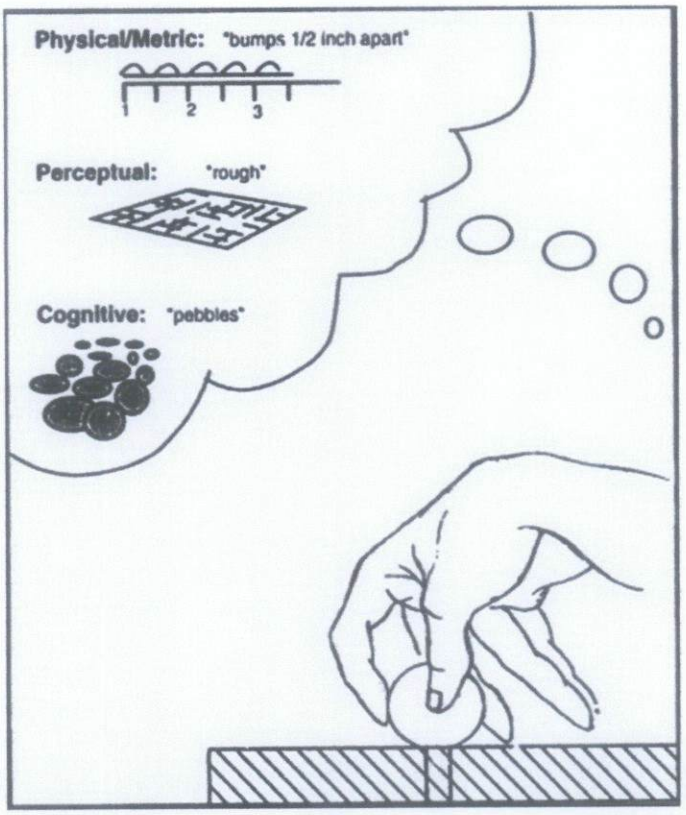


Figure 8: Three styles in people's description of how things feel [24].

Under physical/metric description, subjects describe textures indicating for instance 'the bumps on the surface are ½ inch apart'. In perceptual description subjects describe the texture base on what they perceive of it for instance slippery, rough or sharp. Subsequently cognitive descriptions are those that can invoke particular objects or situations. Under this description there are four distinctive categories which are:

Semantic: E.g. pebbles, stones, balls, nuts.

Metaphorical: E.g. 'feels like corduroy'.

Functional: E.g. 'Like driving on a road'.

Affective: E.g. 'pleasant', 'uncomfortable'

Apart from that, Minsky's findings also extend to the description of materials. He suggests that descriptive language for haptic materials and textures has three-layers:

- Physically-based
- Perceptually-based
- Representative-based

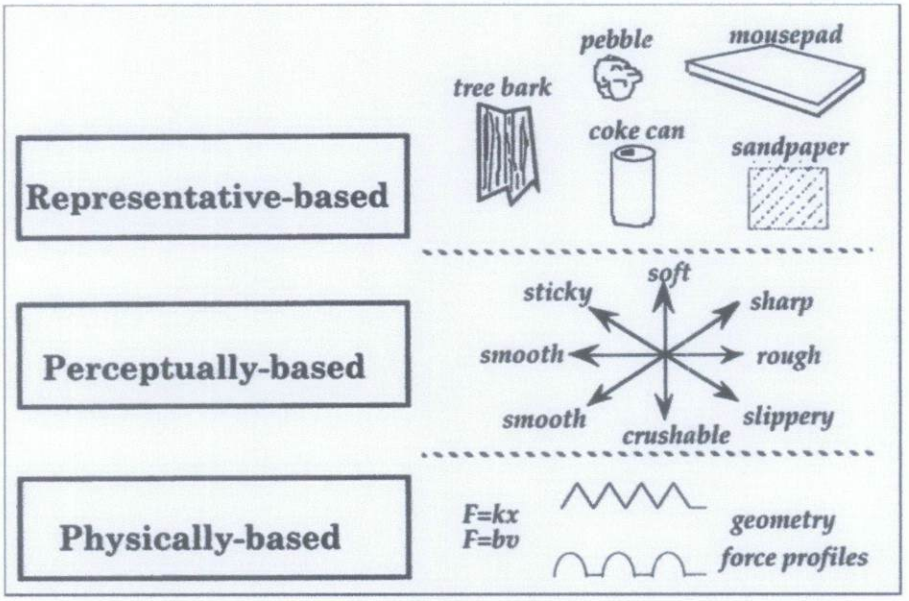


Figure 9: Three layers of description of haptic materials [25].

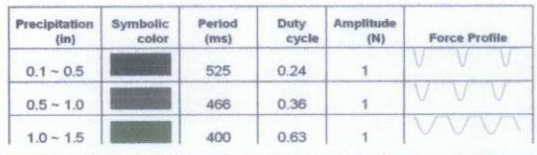
Physically- based descriptions or models are specified using physical properties of the material, surface or object that we wish to simulate. For example, the exact surface geometry of a textured surface is a physically-based description. When specifying varying amounts of friction, a model that uses geometric descriptions of the microscopic properties of a surface would be a physically based description [26].

Perceptually –based descriptions or models are specified using parameters of perceptual primitives. For example, one might specify a degree of roughness, stickiness or softness.

Representative-based descriptions use direct description of particular objects or materials to specify a simulation object. In order to make use of representative-based descriptions, there must be a way of translating them into perceptually-based or physically-based descriptions. For example, a coke can is thin metal; it is hard, yet crushable.

With the above explanation of Minsky's theory, we move on to the related works in haptic visualization which will use the theory.

Reported studies on haptic visualization could be broadly classified into two categories (i.e. quantitative and qualitative) depending on how the information is gathered. The studies that dealt with collecting numerical haptic data could be categorized as quantitative whereas those that involved eliciting people's subjective opinion based on their touch sensation perceived could be classified as qualitative. Despite the different methods used in terms of how the haptic data is collected, the final outcome for both categories involve representing or displaying the information visually. Tables 1a and 1b summarize those related works from both quantitative and qualitative categories of haptic visualization, respectively.

Category	Application	Haptic Visualization Technique	Source
	Weather - Flight Planning Tool	- Force profile applied when turbulence occurs  - Force profile applied for precipitation 	Chaehyun Lee et al (2008)

Precipitation (in)	Symbolic color	Period (ms)	Duty cycle	Amplitude (N)	Force Profile
0.1 ~ 0.5		525	0.24	1	
0.5 ~ 1.0		466	0.36	1	
1.0 ~ 1.5		400	0.63	1	

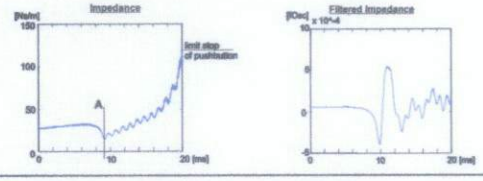
Quantitative			
	Haptic Impression	- Application of the model and method on the analysis of a key's impedance during press, with the haptic click happening at time-index and corresponding filtered impedance with respect to haptic perception. (Thosten). 	Thorsten A. Kern et al (2007)

Table 1a: A summary of related works on haptic visualization: Quantitative measures

In Table 1a, both applications i.e. weather flight planning tool (Chaehyun Lee et al, 2008) and haptic impression (Thorsten A. Kern et al, 2007) involved collecting real numerical data and represent or display it visually to make the users understand the meaning of the haptic data. The weather flight planning tool is about rendering the weather features (wind, precipitation and turbulence) which were in data formats such as tabulated digital data, graphical and audio descriptions haptically from a map in a website. Users could feel the weather when they place the cursors on a specific spot on the map. Based on the force profile shown, users are able to interpret the meaning of the haptic data with regards to the weather. Similarly, haptic impression in Table 1a whose aim is to have an approach to measure haptic sensations provides an associated visual representation of the haptic data. Thus these researches use the quantitative values such as amplitude, frequency and so on to simulate the actual haptic sensation of the real world phenomenon.

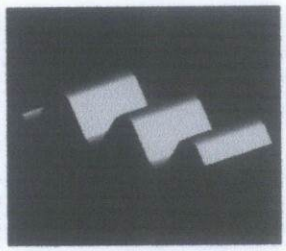
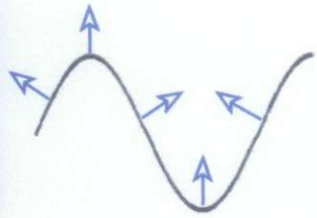
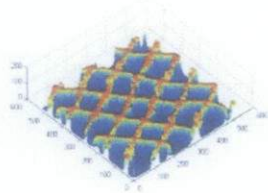
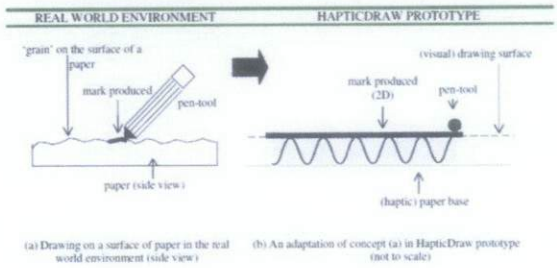
Category	Area / Domain	Haptic Visualization Technique	Source
Qualitative		- Profile of the texture and indication of forces resulting from amplitude and frequency of haptic texture wave.  	McGee, M.R. (xxxx)
	Texture perception	- Visual texture images and the mapped texture in 3D plane.  	Adi, W. & Sulaiman, S. (xxxx)
	Drawing domain	- A comparison between real world drawing and haptic interfaces drawing experiences. 	Sulaiman, S. et al (2010)

Table 1b presents related works that involve collecting haptic data qualitatively. While McGee (2007) and Adi & Sulaiman (2009) focus on general haptic texture perception, Sulaiman et al (2010) concentrate on haptic texture perception but in a specific domain which is the drawing domain. All

these three research works share a similar technique in rendering the haptic force feedback and similar approach in discriminating the haptic textures. The simple sine waves technique was used to render the force feedback in order to feel the haptic textures while Minsky's technique in describing human haptic perception (Minsky, 1995) was adopted. McGee analyzed the texture roughness of a surface and came up with a visual profile of the associated haptic texture. Similar concept in determining haptic textures has been used in Sulaiman et al (2010) to study users' haptic experience in a drawing application.

There are two important points that should be highlighted from the studies presented in Table 1b. The first is the need for a visual representation of particular information to aid presentation of haptic information. In the case of McGee and Sulaiman, the illustration of the sine waves is needed to assist in rendering the force feedback whereas in Adi & Sulaiman, visual texture images on a 3D plane are required. The second point Minsky's categorization on how people perceive haptic feedback is commonly used among researchers. As explained previously, Minsky suggests that human describe and visualize haptics using these three categories: (i) physically-based (ii) perceptually-based and (iii) representative-based.

These two pieces of important information may be useful for designing haptic interactions in a system. What we find useful for this study from the previous research in haptic visualization is the use of Minsky's theory and also the qualitative approach of eliciting people's subjective opinion in how sensations felt like. Minsky's theory can be used as a base for representing pain sensation where it is appropriate. Meanwhile data can be gathered using the qualitative way by instigating people to give opinion on what they felt during and acupuncture treatment.

The significance of having a needle inflicted pain taxonomy

Haptic feedback in terms of pain is an important, yet under-explored, element in human-computer interaction [27]. Its integration could benefit many computer-based applications in areas such as medical training, pain simulation and pain related phobia reduction. In terms of acupuncture, the feedback received during interactions provides information about the needle's surface texture, shape and weight and also the haptic description and pain degree involved. This information enhances the sense of realism in when we are to develop systems in a computer environment [28].

In terms of describing pain sensation, we can say that pain is very hard to be described due to its vagueness. In attempts of eliminating the vagueness, I am suggesting a classification taxonomy for pain – needle inflicted. In terms of research, such an area hasn't been explored by others yet, especially in the field of computer, namely haptics and virtual reality. Having a classification of pain sensation will be helpful in terms of further research of the area and also in order to build systems or designs that can help reduce pain phobia and so on.

Why I am saying that a classification is needed to aid designers is because of the nature of haptic designing itself. There are two broad areas of study pertaining to haptic interface design. The first, more dominant, area involves applying haptic feedback for interactions [29]. In this area, information obtained from the psychophysics field plays an important role. Interface designers use findings on how people perceive and manipulate active and passive exploration of touch [30] to simulate haptic behaviour for interactions. The second area involves the creation of successful interactions; this typically takes a "top-down" approach, addressing particular aspects of physical interaction in the real world [31].

In short, we can say that, to build systems related to haptic feedback, the designers will need a basis of reference. And such a reference is classification taxonomy. Here it would be pain taxonomy. Another reason, on why we are doing the classification is to identify most commonly used vocabulary in terms of describing pain. When we gather feedback from users on how the perceive

the environment, it is easier to build systems based on the feedback gathered. In other words, it makes the system more realistic.

Related paper as a basis for reference for identifying pain related cues

Haptic feedback has been investigated in a range of applications, including the art-related context been considered here, and also areas such as medical training and systems for blind users.
A similar research that has been done of haptic feedback is, Haptic Cues for Supporting Interaction Design in the Drawing Domain [32]. The motivation for the study was that the haptic cues in previous applications of art and drawing have been found to be insufficient for users [33]. This hinders the users from interpreting correctly the virtual haptic world they are interacting in. In such cases, multimodal interactions are usually considered, in which haptic feedback is combined with visual, audio or visual and audio cues .Even though there have been many attempts to include haptic cues such as softness, hardness and stiffness in the interface design, the integration is still not clear in terms of how these cues are chosen and when they should be applied for interactions. Thus, the role of haptic cues is poorly understood. More work was still needed to understand and exploit the capabilities of the haptic cues in multimodal interaction. Integrating haptic cues is particularly challenging because the haptic modality is very context dependent, so that the choice of haptic feedback depends on the domain one is working in. A different domain of applications requires a different set of haptic cues to enable users to discriminate the haptic effect well. So the study suggested that, to design useful haptic feedback for creative drawing, it is necessary to investigate possible haptic cues – in the form of tactile information – for the drawing domain.

The study was designed to identify tactile features that are significant in the drawing domain. The main objective of the study was to compile a structured vocabulary of users' experience when using drawing tools, focusing on the haptic properties and features of the drawing domain. In addition, the visual

cues that were related to the tactile sensation while drawing were also examined in the study.

The method used in the study consisted of 21 traditional artists took part in the study (13 females and 8 males). 2 of the artists paint for living, while the rest were 15 undergraduate and 4 postgraduate students from the Slade School of Art at University College London. All the artists were interviewed and the conversations were audio recorded. During the interviews, the artists were given a collection of 9 pen-like tools consisting of 4 pens, 3 pencils, a crayon and charcoal to work with. They were asked to describe the tactile sensation and the visual appearance of the tool while holding it in their hands. Using the tool, they were asked to do free drawing or writing on two different types of textured paper. During their interactions, they were asked to talk out loud about the tactile sensation they experienced and the appearance of the mark produced when they used each tool and paper. They were also encouraged to talk about any similar experiences using drawing tools in their daily work.

The recorded conversations were transcribed to obtain 21 sets of data, each of which contains information on an individual artist's experience using the tools. From each set, the vocabulary that was used by the artist was identified. These vocabularies were examined to identify the terms used by each artist across all the 9 pen-like tools and two paper types. From the 21 sets of data, any similar terms were grouped under the same category. The groups obtained were further classified into a higher level based on the actions made by the artists during the study, so as to determine at which stage of interactions a particular haptic cue should be applied in the interface design. To ensure consistency of the terms used by the artists when describing each tool, an orthogonal data analysis was performed. In this, the transcribed data was transformed into 9 different sets based on the tools used in the study. The terms used by all the 21 artists to describe the tactile sensations when using each tool were identified. These terms were cross-examined to assess their consistency with the earlier groups. A similar approach was taken for identifying the related visual cues.

Results

Type of Interaction	Action	Properties	Features	
Hand & Tool	Hold	Surface texture (tool)	Smooth	Bumpy
			Soft	Hard
			Slippery	Plasticky
			Rubbery	Metallic
		Shape	Short	Long
			Thin	Thick
			Round	Sided
		Weight	Light	Heavy
		Temperature	Cold	Warm
		Grip	Slipping	Not slipping
Tool & Surface	Press	Surface texture (tool)	Soft	Hard
			Sticky	Dry
	Push	Surface texture (paper)	Smooth	Rough
		Friction	Soft	Hard
			Sticky	Dry
			Waxy	Powdery
			Smooth	Glide
			Flows	Silky
			Velvety	Creamy
			Stiff	Sharp/ scratchy
			Bumpy/ rough	
Hand & Surface	Smudge	Surface texture (tool & paper)	Soft	Rough

Table 1c: Properties and Features of Haptic Domain

The data analysis has resulted in two inter-related sets of information on the haptic and visual elements. In this study, both sets of elements were classified and presented based on the interactions involved in the drawing domain. The properties and features of the haptic cues identified are presented in Table 1c. There are three main types of interactions that involve the sense of touch. The 'hand and tool' interaction occurred when the artists described the tactile

sensation while holding the tool. The 'tool and surface' interaction occurred when the tool touched the surface of the paper, as the artists were drawing or writing, and the 'hand and surface' was when the artists used their own fingers to smudge the mark on the paper.

The action "hold" relates to the first type of interaction. When holding the tool, the haptic properties that could be assessed were the surface texture, shape, weight, temperature and grip of the tool. For the surface texture property, the artists commented on the smoothness, hardness, slipperiness and material of the tool. They noted the shape of the tool in terms of its length, width and roundedness, and the weight in terms of its heaviness. The temperature of the tool was noted in terms of its coldness and the grip of its slipperiness. The second type of interaction involves two main actions made by the artists: "press" and "push". In this analysis the action "press" is considered as a passive touch [34]. It occurred immediately after the tool touched the paper and the artist could feel the surface texture property of the tool; this could be 'soft', 'hard', 'sticky' or 'dry'. It also happened when the artists made 'dotted patterns' on the paper. In contrast, the action "push" involved active haptic exploration [35]. The artists applied force and made a mark on the paper. The "push" action provided information about the surface texture of the paper. It also produced a friction property between the tool and the paper, resulting in features including all those noted under the "press" action and also other cues such as 'smooth', 'glide', 'stiff', and 'sharp/ scratchy' (see Table 1c for a full list).

The third type of interaction involved the artists smudging the mark with their fingers ("tool"). They could feel the properties of the surface texture of the paper while interacting with the "tool". The 'soft' and 'rough' features obtained for this interaction are the overlapping cues when surface texture (tool) and surface texture (paper) of actions "press" and "push", respectively, are combined.

Further work suggested by the study is that the study is the first step in developing and testing a drawing tool that can support the creative processed of artists by providing appropriate haptic feedback within their interactions

with digital tools. Prior to system development, further clarification of the association.

Concepts to be included in the current study

When we look at the previous paper, the findings and data analysis, lead to a concept which can be used to identify the haptic cues in describing pain sensation. Similar approach can be taken with patients in order to gather feedback on the variety of sensation described. Hence, the current study will use the element of card sorting and also interviewing patients for the use of data gathering and also taxonomy generation. This method is proven to be effective in pooling together groups of data which is then used to construct a classification table, here – pain classification. The classification constructed will be then further evaluated using expert opinions such as medical practitioners and haptic experts.

Chapter 3

METHODOLOGY

3.1 Research Methodology

The primary research objective of this study is to construct taxonomy of needle inflicted pain sensation. In order to come up with the final outcome, here being the taxonomy, a series of studies has to be done primarily on acupuncture patients as our motivation for this study is to reduce phobia towards needle inflicted pain sensation in acupuncture patients. Apart from that we will also carry out surveys on a general pool of people on their opinions or treatments that require needle piercing and also their opinion on pain sensation. These data will be then be gathered to be analysed and then the1st draft of taxonomy will be generated. Following the first draft, a validation exercise will be carried out through card sorting activity and also interviewing the experts who consist of a certified acupuncture doctor and a professor in computer haptics.

The breakdown of the steps taken in this study is as follows:

Study 1- Survey on Pain Sensation

For study 1, I chose the approach of carrying out a survey on a pool of people in regards of their opinion about pain sensation. This method is chosen as surveys are most suited for gathering descriptive information.
A structured survey form is generated with formal lists of questions that related to pain sensation and acupuncture treatment. All respondents are asked the same set of questions. The questions asked are also direct in manner.
Direct Approach: direct questions about participant's behaviours and thoughts.
The medium in which the survey is carried out on is through the internet where a random pool of people is given the link of the survey to be tried out. It is purely on voluntary base and they aren't paid to do the survey.

The data gathered through the survey is then used to test the accuracy of the hypothesis. The hypothesis here being people are generally afraid of needle based treatments and the fear is caused by phobia towards pain.
Furthermore, the results of the survey are used to analyse the feasibility of the study taken and also whether the study is headed in a correct direction. The survey data is grouped into table and charts using Microsoft Excel to enable greater understanding of the survey results for further analysis and evaluation.

Study 2- Interview Acupuncture Patients

A short study was conducted on 20 acupuncture patients in an acupuncture clinic in brickfields. The study was conducted with the consent of the acupuncture doctor at the clinic. Before any patient were interviewed, they were given a consent form to be signed indicating that they agreed to be interviewed and the data collected can be used for this study.
The patients were interviewed using a combination method of structured and unstructured interview. Unstructured interview: interviewer probe respondents and guide the interview according to their answers. The patients were also asked a series of direct and indirect questions.

The advantage of using the combination method is that it can be used to collect many different kinds of information which comes in useful at the data analysis stage.

A tape recorder was used to record the entire interview session to keep an exact record of what was said. This is critical for accuracy and for many kinds of data analysis.The limitations of carrying out these interviews are:

-Respondent's reluctance to answer questions asked by unknown interviewers about things they consider private.
-Some patients do not like to be interviewed as they do not want information of their ailment to be used in a study.

These limitations are overcome by using the consent form, whereby patients' consent is first taken before an interview commences.

The interview forms and questions are constructed using Minsky's theory of how people describe things as a base for description. Yet patients other inputs are recorded too.The data collected from the interview on how patients describe the pain sensation involved in the treatment is then transferred into charts and tables using Microsoft Excel.These charts and tables are analysed and the information gathered is used to construct the first draft of the taxonomy.

Constructing the Taxonomy

The first draft of taxonomy is drafted using the vocabulary identified from the interview of acupuncture patients.The properties are aligned together in groups.The first draft is then validated through Validation Exercise 1 and Validation Exercise 2.

Validation Exercise 1

Card Sorting is a technique for exploring how people group items.

Advantages of Card Sorting:

- Is easy and cheap to conduct
- Enables you to understand how 'real people' are likely to group items
- Identifies items that are likely to be difficult to categorize and find
- Identifies terminology that is likely to be misunderstood.

How is the Card Sorting Activity Conducted?
Subjects: 5 undergraduate students from Universiti Teknologi Petronas are recruited on voluntary basis to do the card sort. In order to participate in the card sorting activity, they will have to agree to go through a basic acupuncture therapy session which mainly involved the face and hand region.

The subjects are briefed on the aim of the study and also on key aspects of an acupuncture treatment before the validation exercise commences.
When the subjects go through the treatment, they are asked to describe the pain sensation felt aloud. This is to identify vocabularies used by the subjects during the treatment to be compared to earlier findings.

After the treatment session, we proceed to the card sort activity which consists of:

Names of properties to be categorized are printed on individual cards. Cards are large enough to accommodate the names in a font that participants can read easily when spread out on a desk. Participants are asked to group properties in a way that makes sense to them. Once all participants have completed the exercise, the data is entered in a spread sheet, and groupings are examined. There will be general agreement about many properties, and these groupings will be fairly apparent.

Validation Exercise 2

A tape recorder was used to record the entire interview session to keep an exact record of what was said. This is critical for accuracy and for many kinds of data analysis.
Findings from study 2 and also Validation Exercise 1 is discussed with the specialists as mentioned before. The dimensions cues identified is reviewed by them before finalisation of the taxonomy.

3.2 Methodology for Solution Proposed

The methodology that will be implemented to complete this study will be the System Development Life Cycle (SDLC). The steps will be shown below in Figure 1 involving six processes.

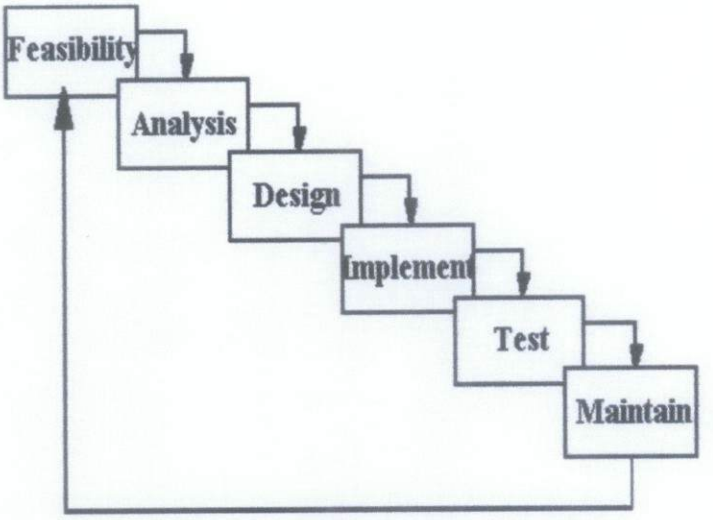


Figure 10: System Development Life Cycle

Feasibility

The feasibility study is used to determine if the study should get the go ahead. During this feasibility study, the study plan and budget estimates will be worked on.

Requirement Analysis and Design

The analysis phase involves gathering requirements for the study, in this case about the current developments in reducing phobia of pain and how people feel about acupuncture treatment. This stage also includes a detailed study of how people perceive needle inflicted pain sensation. Meanwhile, design focuses on survey design, interview structuring, and design of validation exercises which involve designing the card sorting activity and questions for expert interview.

Implementation

In this phase, the data gathered is translated into a classification of pain sensation.

Testing

In this phase, the findings will be validated as a whole. The findings are validated to ensure accuracy of the results generated. Expert opinions are sought after to validate the findings in medical aspect and also haptic aspect.

The validation will be used to further improve the 1st draft of the taxonomy. The validation exercise will also ensure that the study is corresponds to medical and also technical requirements when in future Virtual Reality applications base the study's findings as a template for building solutions in the area of reducing pain related phobia.

Maintenance

The study will be frequently reviewed to facilitate advancements in research and findings in the area of classification of pain sensation.

Chapter 4

Results and Discussion

4.1 Survey Results for Study 1

A short survey was conducted to study the general audiences' perception of acupuncture and pain. The survey form was distributed online to a random sampling of people. 73 people responded to the survey. The objective of this survey is to provide an overview on how people perceive the pain sensation involved in an acupuncture treatment. The survey consists of 8 questions. Refer to appendix C for survey form.

Question 1

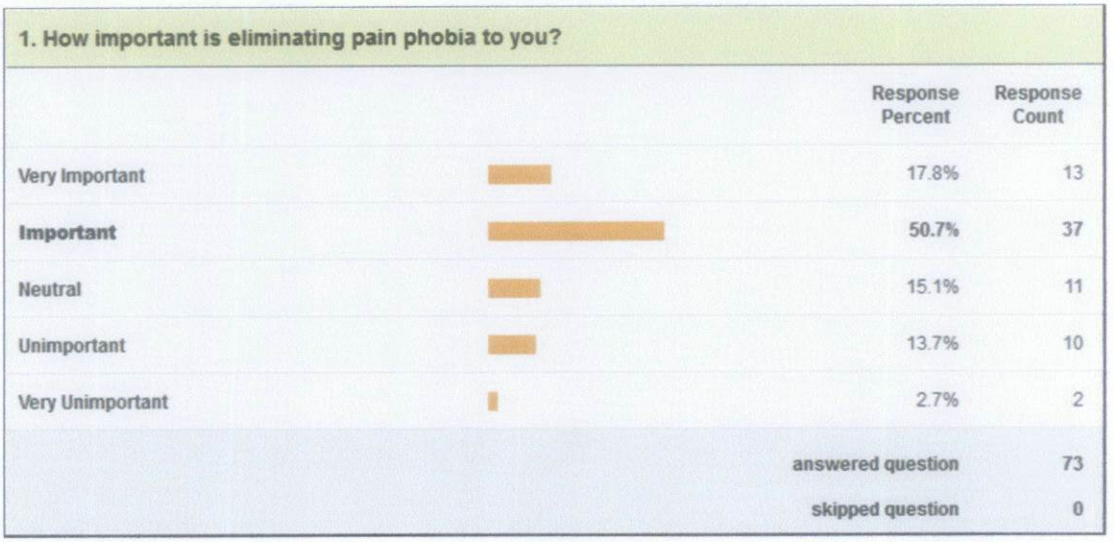


Figure 11: Question 1 from the survey.

Importance	Response Percentage (%)
Very Important	17.8
Important	50.7
Neutral	15.1
Unimportant	13.7
Very Important	2.7

Table 2: Response for Question 1.

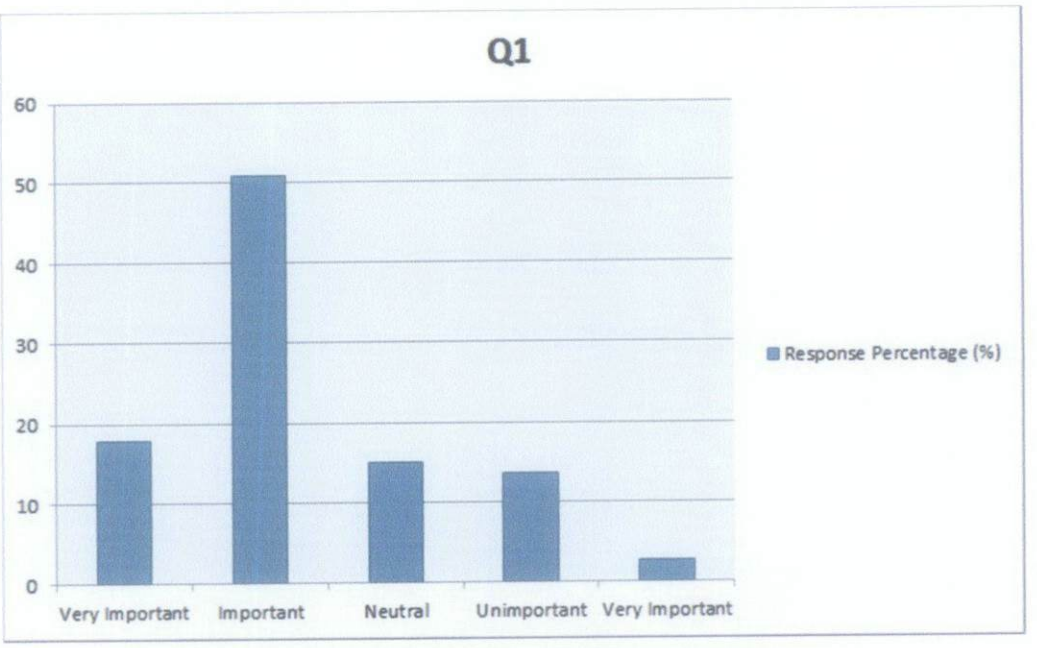


Figure 12: Importance of eliminating pain.

A majority of the respondents viewed that eliminating pain is crucial, with a combined 50.7% at important and 17.8% at very important. They add up to 68.5% (more than half) or the respondents viewing the matter as crucial. Only 16.4% of the respondents viewed eliminating pain as not crucial and 15.1% of respondents were undecided.

Question 2

2. Do you think a Virtual Reality simulation will help reduce phobia of pain?

	Response Percent	Response Count
Strongly Agree	27.4%	20
Agree	43.8%	32
Neutral	16.4%	12
Disagree	8.2%	6
Strongly Disagree	4.1%	3
answered question		73
skipped question		0

Figure 13: Question 2 from the survey.

Opinion	Response Percentage (%)
Strongly Agree	27.4
Agree	43.8
Neutral	16.4
Disagree	8.2
Strongly Disagree	4.1

Table 3: Response for Question 2.

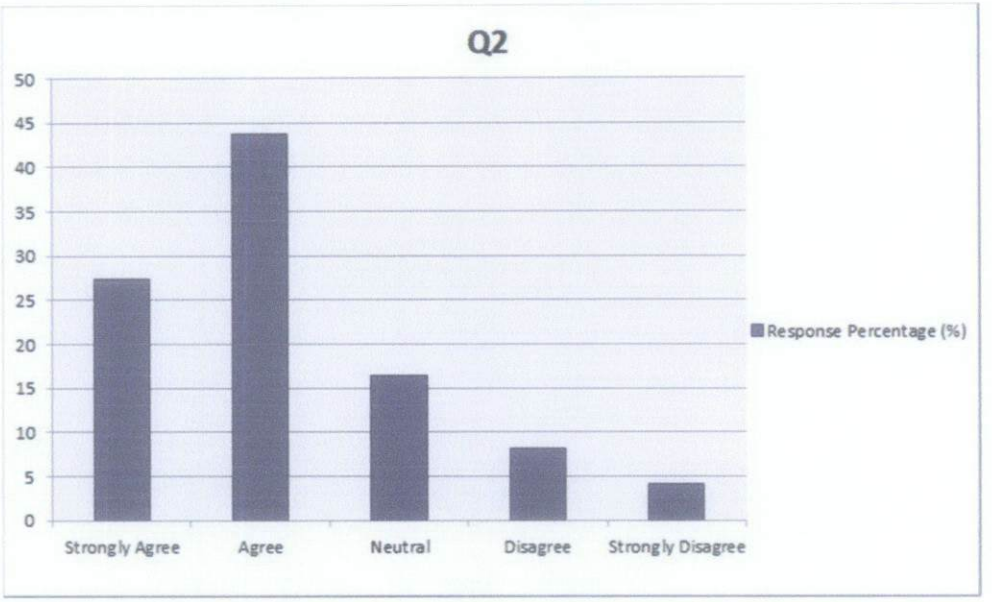


Figure 14: Opinion on Virtual Reality in phobia reduction.

A majority of the respondents supported that virtual reality simulation will help reduce phobia related to needle inflicted pain, with a combined 43.8% agreeing and 27.4% strongly agreeing. They add up to 71.2% (nearly ¾) of the respondents support the idea of virtual reality in reducing phobia towards pain. Only 12.3% of the respondents answered that virtual reality won't help reduce phobia and 16.4% of respondents were undecided probably due to unfamiliarity to the term virtual reality.

Question 3

3. Have you heard about virtual reality in reducing phobia?		
	Response Percent	Response Count
Yes	74.0%	54
No	26.0%	19
answered question		73
skipped question		0

Figure 15: Question 3 from the survey.

Familiarity	Response Percentage (%)
Yes	74.0
No	26.0

Table 4: Responses for Question 3.

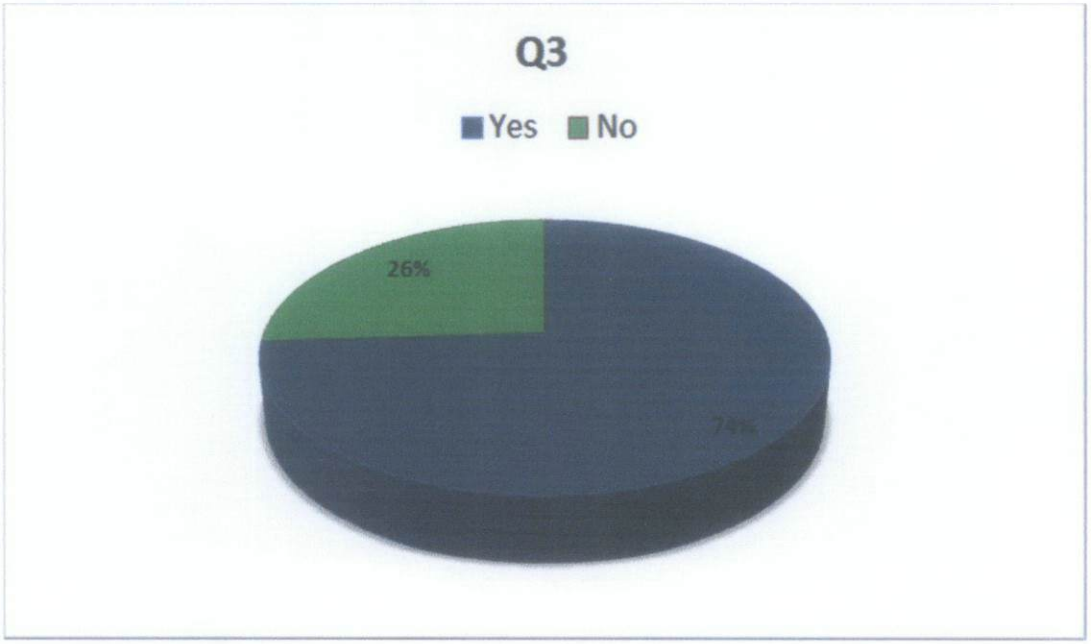


Figure 16: Respondents' familiarity towards virtual reality

Nearly ¾ of the respondents at 74% are familiar with virtual reality. Only 26% aren't aware of the term virtual reality.

Question 4

4. Are you aware of the term pain threshold?		
	Response Percent	Response Count
Yes	40.3%	29
No	59.7%	43
answered question		72
skipped question		1

Figure 17: Question 4 from the survey.

Familiarity	Response Percentage (%)
Yes	40.3
No	59.7

Table 5: Responses for Question 4.

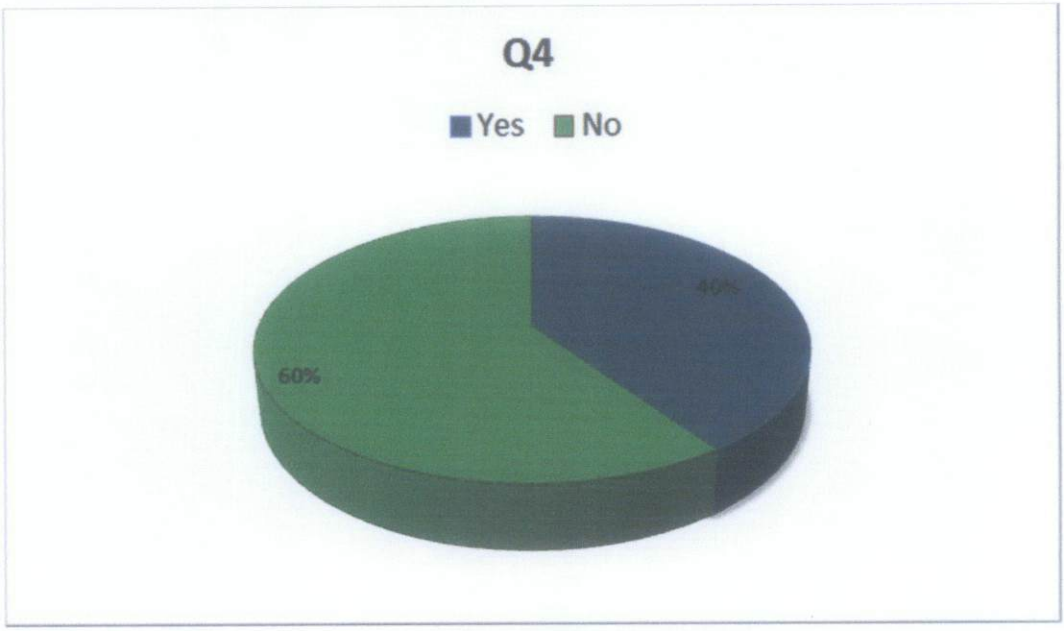
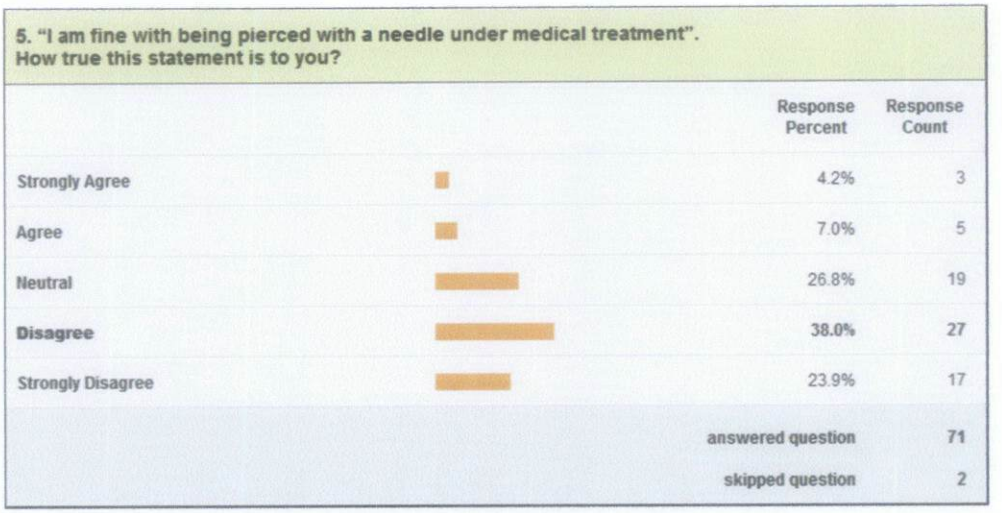


Figure 18: Respondents' familiarity of pain threshold.

More than half of the respondents (59.7%) aren't aware of the term pain threshold. Only 40.3% of the respondents stated that they were aware of the term. One respondent skipped this question. From here, we can deduce that, there are still many who find pain and abstract sensation and hard to describe it.

Question 5



5. "I am fine with being pierced with a needle under medical treatment". How true this statement is to you?	Response Percent	Response Count
Strongly Agree	4.2%	3
Agree	7.0%	5
Neutral	26.8%	19
Disagree	38.0%	27
Strongly Disagree	23.9%	17
answered question		71
skipped question		2

Figure 19: Question 5 from the survey.

Opinion	Response Percentage (%)
Strongly Agree	4.2
Agree	7.0
Neutral	26.8
Disagree	38.0
Strongly Disagree	23.9

Table 6: Responses for Question 5.

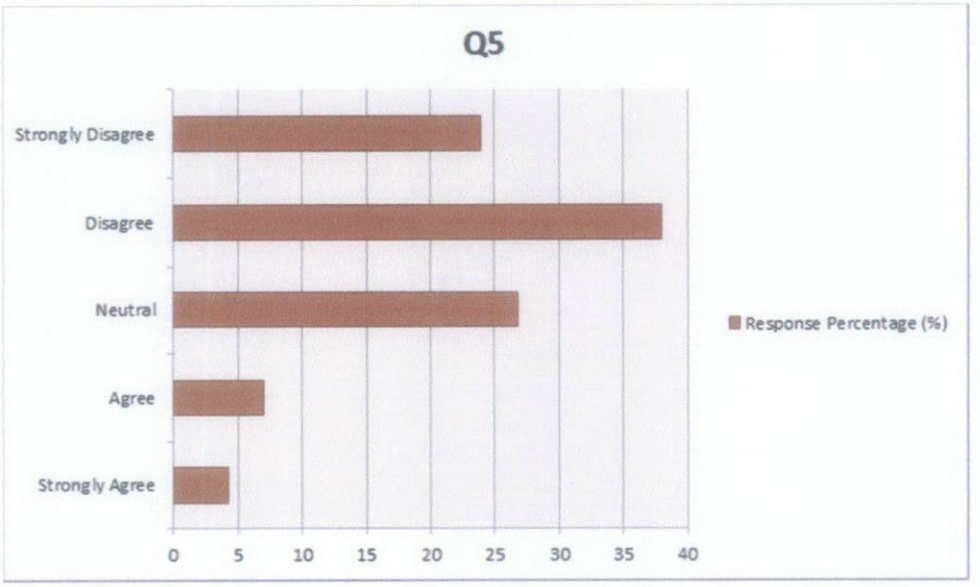


Figure 20: Opinion of treatment requiring piercing

The majority of respondents, 38.0 %, disagreed on taking treatments that required piercing on needles of any kind. This number was followed by 23.9%

of the respondents strongly disagreeing on taking any treatment that required piercing and 26.8 % of the respondents were undecided. The remaining minority of the respondents 11.2 % combined responded agree and strongly agree to taking treatment requiring piercing. Two respondents skipped this question. This question had the most mixed response comparatively to other questions.

Question 6

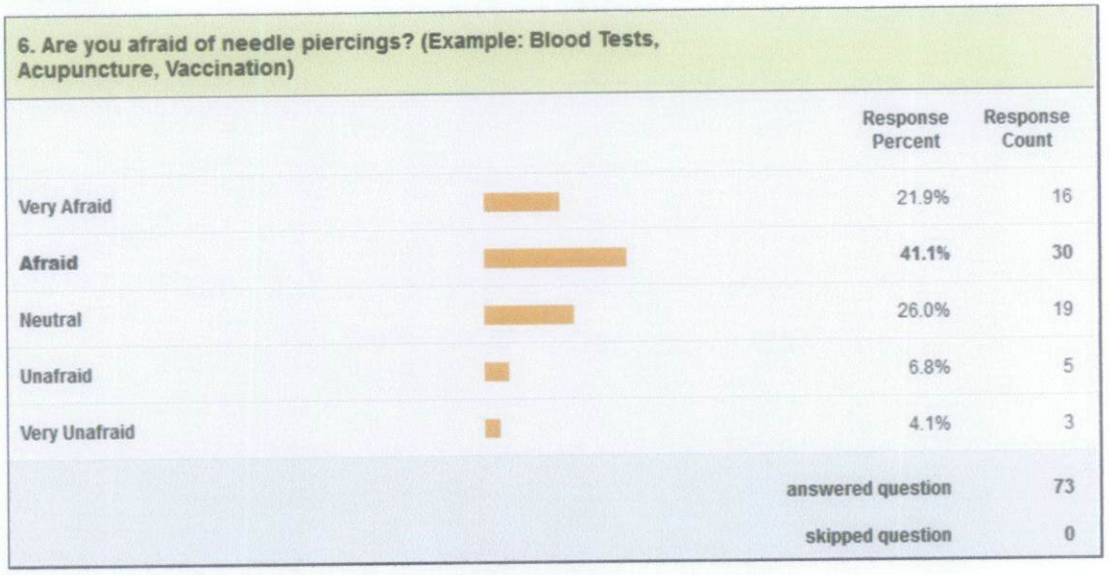


Figure 21: Question 6 from the survey

Fear Level	Response Percentage (%)
Very Afraid	21.9
Afraid	41.1
Neutral	26.0
Unafraid	6.8
Very Unafraid	4.1

Table 7: Responses for Question 6.

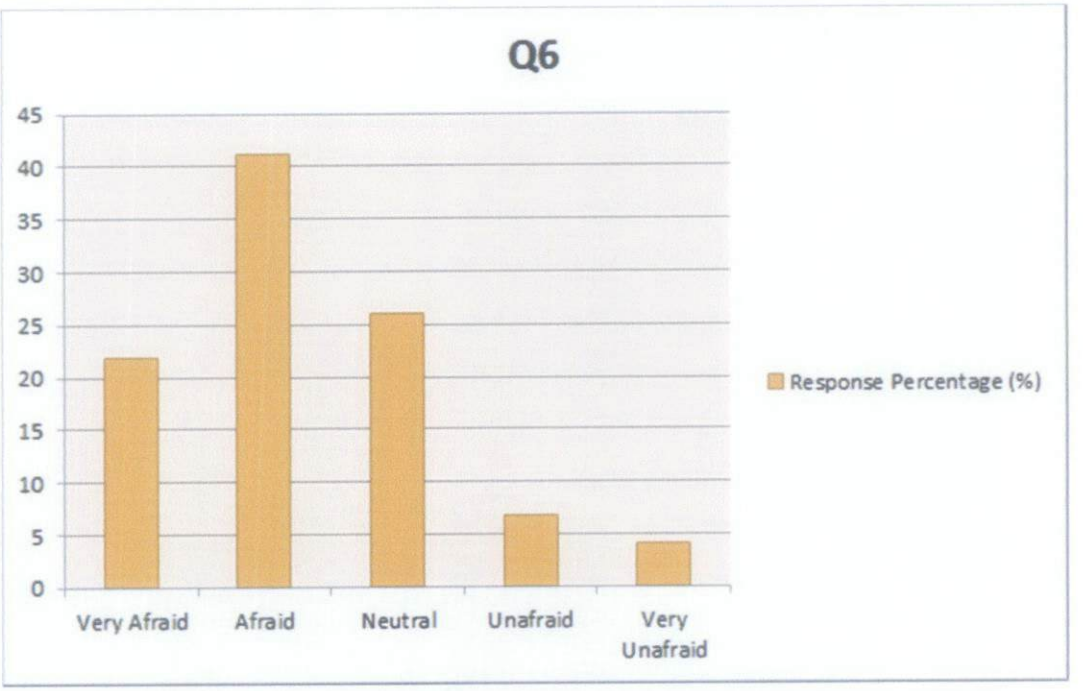
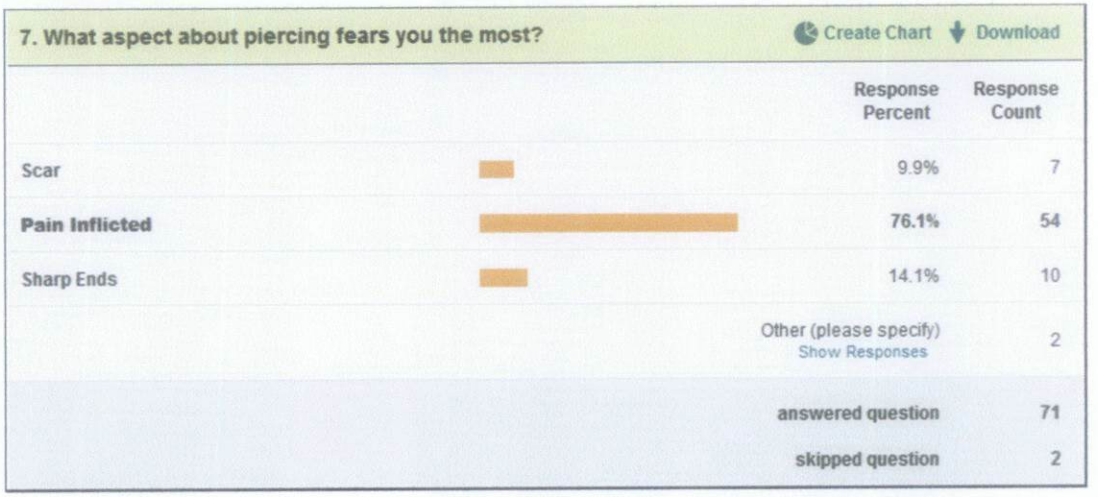


Figure 22: Fear level rating of respondents.

The majority of respondents (63.0 %) rated that they are afraid or very afraid of any kind of needle piercings. 26.0 % of the respondents were undecided. The remaining minority of 6.8% and 4.1 % of the respondents were unafraid and very unafraid respectively. From this we can see that there are a large pool of people out there who are afraid of needle based piercing.

Question 7



7. What aspect about piercing fears you the most?	Create Chart	Download
	Response Percent	Response Count
Scar	9.9%	7
Pain Inflicted	**76.1%**	54
Sharp Ends	14.1%	10
Other (please specify) Show Responses		2
answered question		71
skipped question		2

Figure 23: Question 7 from the survey.

Aspect	Response Percentage (%)
Scar	9.9
Pain	76.1
Sharp Ends	14.1

Table 8: Responses for Question 7.

Others	I am ok with pain
	I take piercings as a hobby

Table 8: Responses for Question 7 under 'others' category.

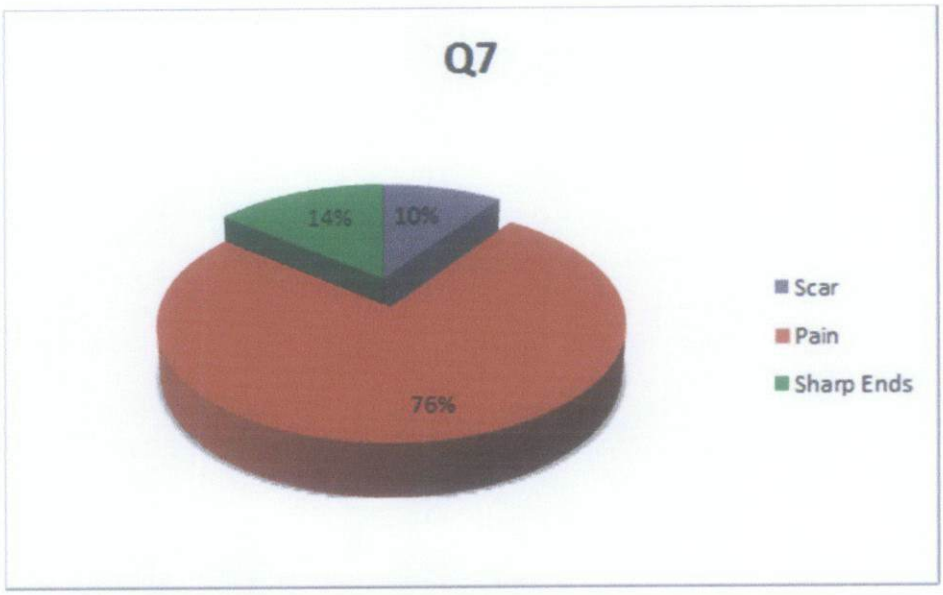
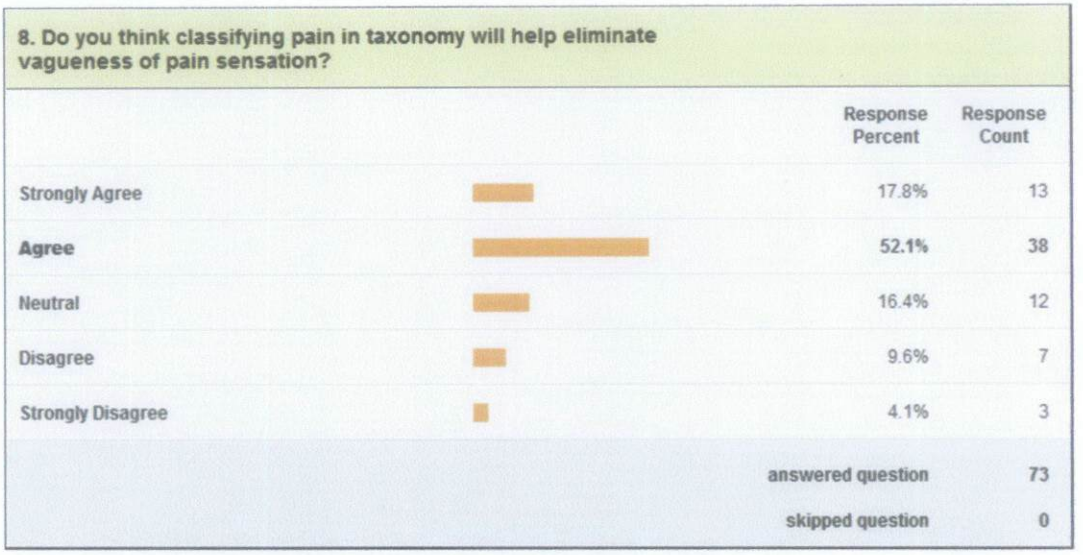


Figure 23: Aspect that influences the fear of piercing.

From the above pie chart, it is evident that 76% of the respondents do not want to take treatments which involve piercing due the phobia of pain. Other reasons include sharp ends and scar but only a minority at 14% and 10% respectively.

Question 8



8. Do you think classifying pain in taxonomy will help eliminate vagueness of pain sensation?	Response Percent	Response Count
Strongly Agree	17.8%	13
Agree	52.1%	38
Neutral	16.4%	12
Disagree	9.6%	7
Strongly Disagree	4.1%	3
answered question		73
skipped question		0

Figure 24: Question 8 from the Survey.

Opinion	Response Percentage (%)
Strongly Agree	17.8
Agree	52.1
Neutral	16.4
Disagree	9.6
Strongly Disagree	4.1

Table 10: Response for Question 8

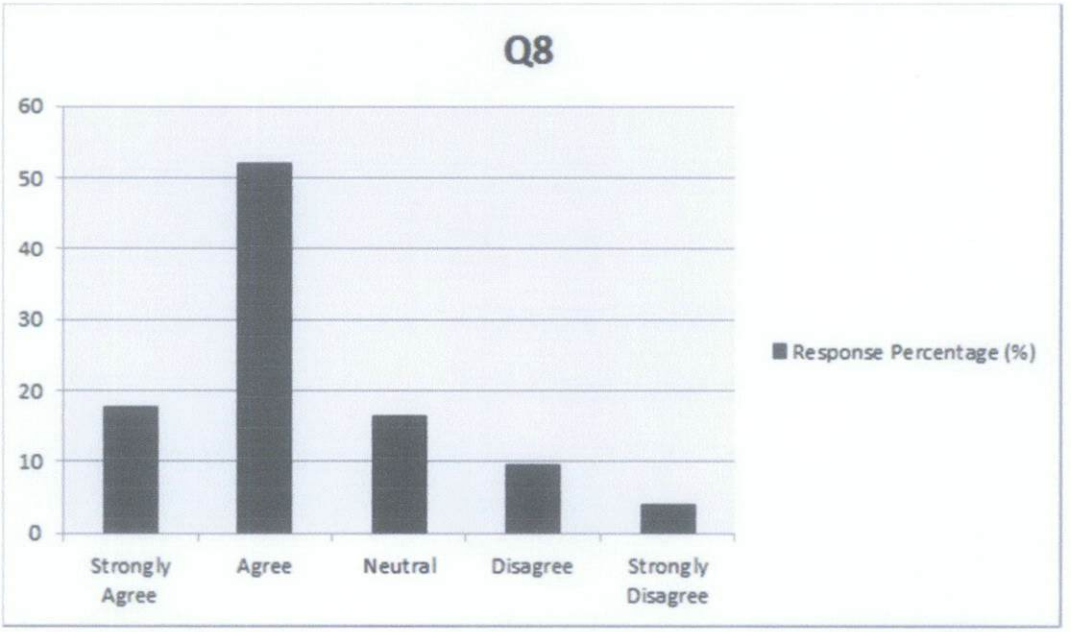


Figure 25: Respondents' Opinion on a taxonomy for classifying pain sensation

The majority of respondents (69.9 %) rated that they agree and strongly agree that having a classification of pain sensation will help eliminate vagueness of pain sensation. 16.4 % of the respondents were undecided. The remaining minority of 9.6% and 4.1 % of the respondents disagreed and strongly disagreed respectively. We can deduce here that, pain has been always an abstract sensation and needs classification to eliminate the vagueness in describing the sensation.

Based on the survey results, it can be concluded that many people in general are afraid of acupuncture treatment or any sort of needle related treatment. The main problem they face is the phobia of pain inflicted from the treatment. The phobia is heightened by the vagueness of pain itself. They don't know what to expect and they refrain from taking the treatment. The survey also shows that many would consider taking such treatments if they phobia of pain was eliminated. And the possible way is through a simulation of the pain sensation. But for that to happen, we first need a classification of the sensation involved. This is the key motivation of this study.

4.2 Interview Results for Study 2

A thorough interview was conducted to study the patients perception of acupuncture and pain. The interview was conducted in an acupuncture clinic in KL with a certified acupuncture doctor. 15 patients responded to the interview. The objective of this interview is to come up with common terms and evaluate how patients describe pain sensation. The outcome is then used to construct taxonomy of needle inflicted pain sensation. The interview consists of 21 questions of open ended and closed and direct questions. Refer to appendix C for Questionnaire form

Question 1

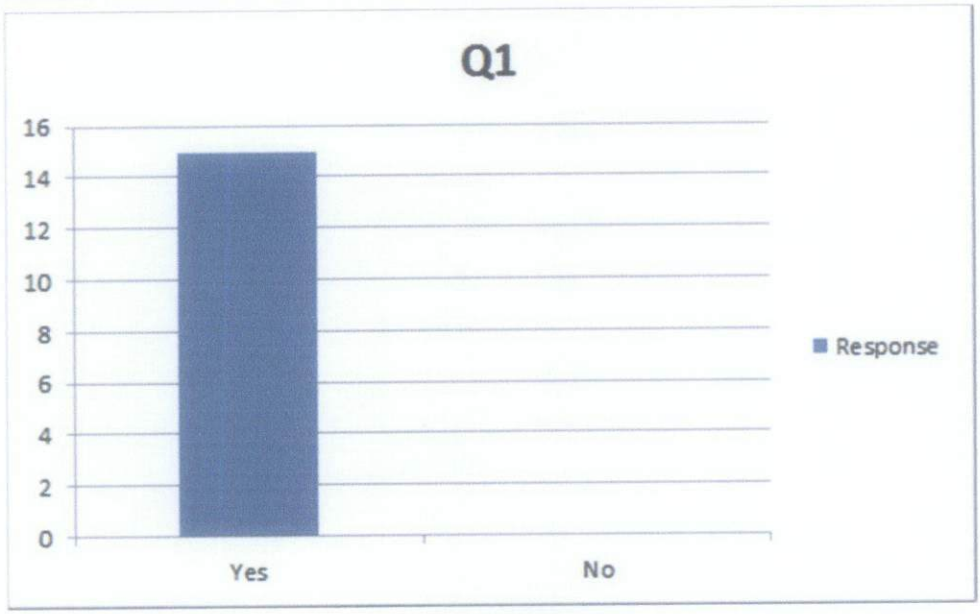


Figure 26: Fear towards acupuncture treatment

From the survey results, all of the patients are afraid of acupuncture treatment.

Question 2

Patient ID:	Response
01	Afraid of needle treatment and pain involved.
02	Don't like needles.
03	Needles.
04	Needle is scary.
05	First time trying and don't like needles.
06	Needles.
07	Anxiety towards first time trying.
08	Don't like painful treatment.
09	First time trying.
10	Anxiety due to sickness.
11	Needles.
12	Needles.
13	Needle and the pain are scary.
14	Don't like pain.
15	Needle.

Table 11: Responses for Question 2

The table above depicts their response when asked what they fear the most about the treatment.

Aspect	Response (%)
Needles	55.6
Pain	22.2
First Time	16.7
Sickness	5.6

Table 12: Breakdown of main aspects influencing fear

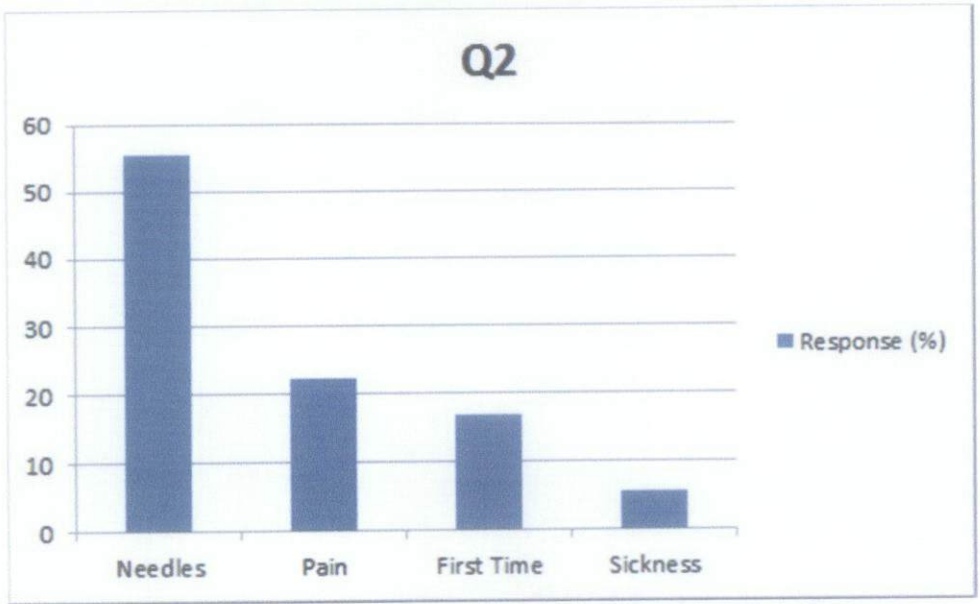


Figure 27: Responses for main aspects influencing fear

From the breakdown above, it is evident that the patients fear needles the most, followed by pain and other minor reasons. Some even gave combination reasons such as fear of needles and pain inflicted.

Question 3

Reason	Response (%)
Best available alternative	26.7
Trust towards the practitioner	53.3
For the sake of trying	13.3

Table 13: Responses for Question 3.

Others	Response (%)
As a last resort	6.7

Table 14: Responses for Question 3 other's category.

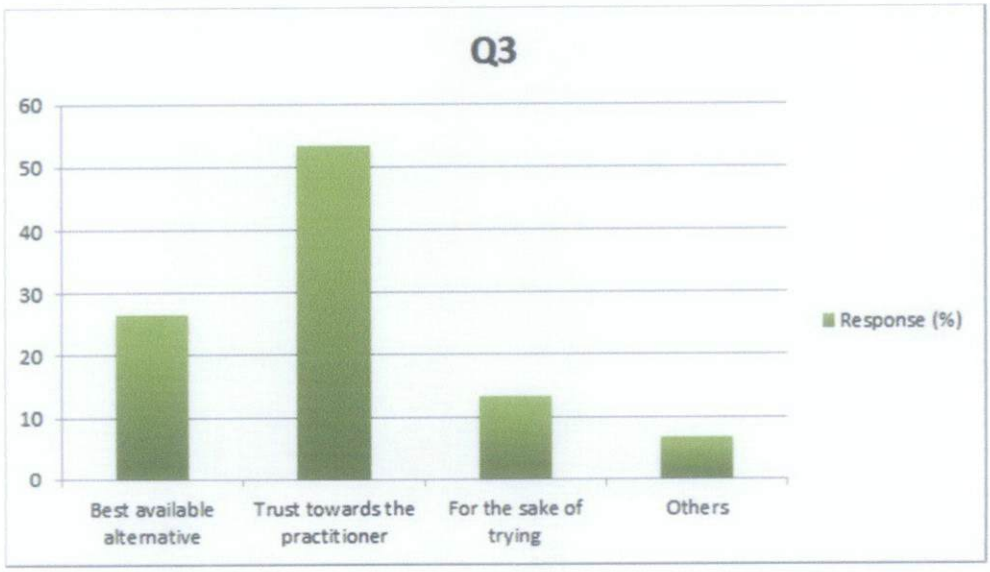


Figure 28: Breakdown of factors influencing treatment seeking.

From the responses given on the question why do you seek this treatment though you fear it, the answers were mixed. Yet the highest ratings were for trust towards the practitioner, followed by best available alternative. Very few answered for the sake of trying as they said, they won't try given they don't have to. Under other's category, one respondent answered as a last resort for their ailment.

Question 4

Patient ID:	Response
01	Thin/short/flat
02	Thick/long/big
03	Fat/short/big
04	Narrow/short/thin
05	Thin/short/narrow
06	Thick/long/big
07	Narrow/short/thin
08	Narrow/short/thin
09	Narrow/short/thin
10	Narrow/short/thin.
11	Narrow/short/thin
12	Narrow/short/thin
13	Narrow/short/thin.
14	Flat/short/thin
15	Narrow/short/thin

Table 15: Responses for Question 4

From the response of their description of the needles, it is evident that there is a pattern of describing the size and also the length of the needle. They commonly answer short/long or narrow/thick or narrow/thin.

Question 5

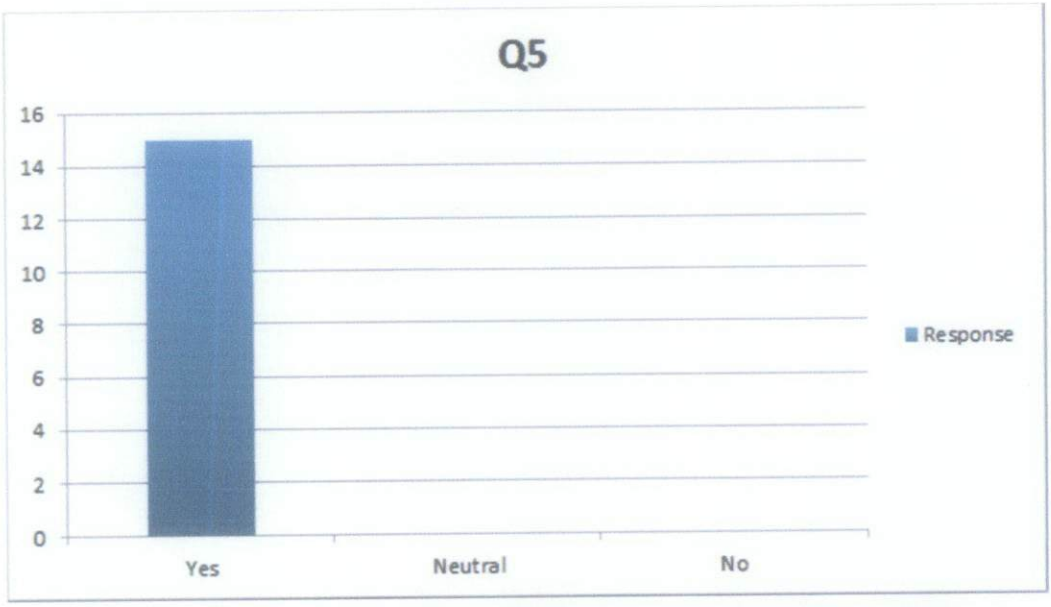


Figure 29: Fear towards shape of needle

All the respondents agreed that the shape of the needle influence the fear towards the treatment.

Question 6

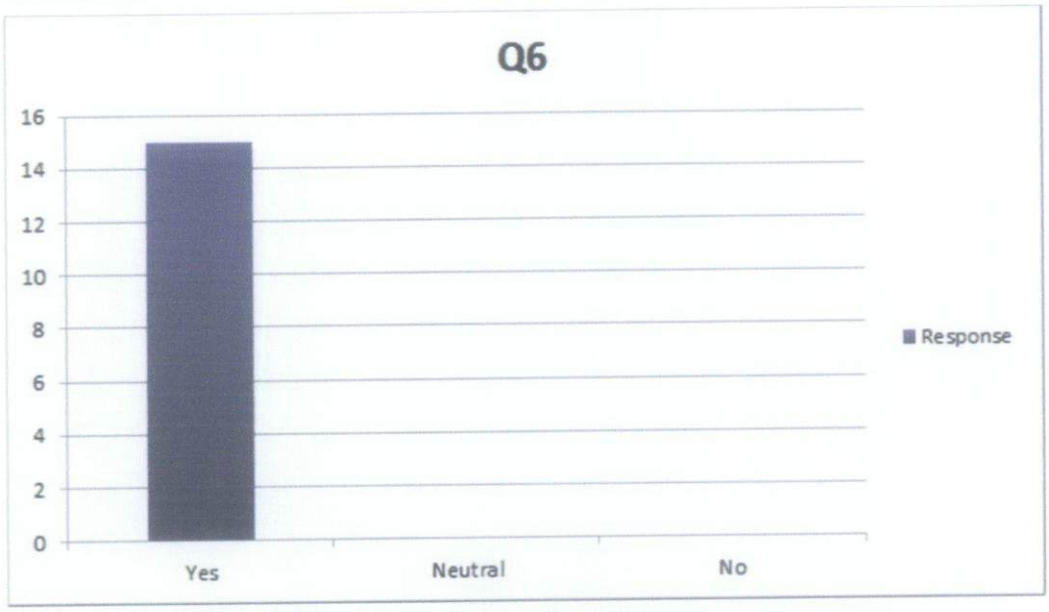


Figure 30: Does the shape influence degree of pain

All of the respondents agree that the shape of needle influences the degree of pain in the treatment given.

Question 7

Significance	Response (%)
Very Significant	46.7
Significant	13.3
Neutral	13.3
Not Significant	20
Very Not Significant	6.7

Table 16: Responses for significance of influence of the shape

The majority of the respondents agreed that the shape of the needle gave great significance in the level of pain. The minority respondent that it didn't give that much of significance, yet it did influence the level of pain.

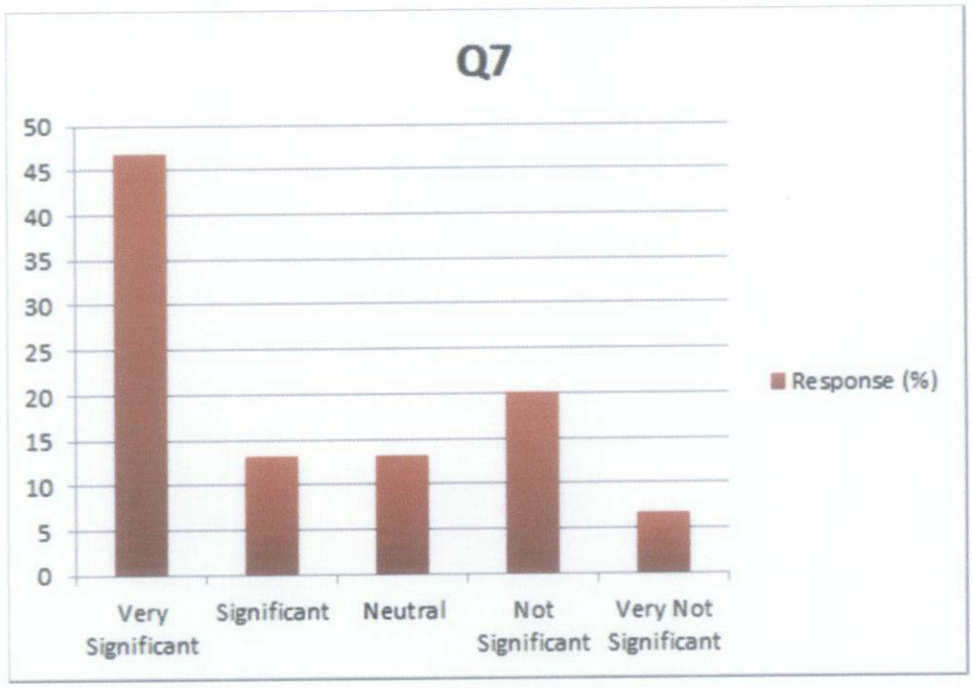


Figure 31: Significance of needle shape towards pain inflicted.

Question 8

Patient ID:	Response
01	Painful
02	Very Painful
03	Very Painful
04	Very Painful
05	Painful
06	Very Painful
07	Very Painful
08	Painful
09	Very Painful
10	Very Painful
11	Very Painful
12	Very Painful
13	Very Painful
14	Painful
15	Very Painful

Table 17: Degree of Pain during insertion

Common pattern found in the responses is that patients view it painful or very painful. None said neutral or not painful.

Question 9

Patient ID:	Response
01	Stinging like bee sting
02	Sharp like being cut by knife
03	Stinging like ant bite
04	Prickly like splashing hot water
05	Stinging like mosquito bite
06	Sharp like electrified
07	Sharp like stepping on glass
08	Stinging like ant bite
09	Prickly like touching new wound
10	Sharp like during blood test
11	Sharp like stepping on nail
12	Stinging like pinching skin using nails
13	Prickly – hot water
14	Stinging like mosquito bite
15	Stinging like bee sting

Table 18: Pain sensation felt at insertion

Commonly found words in describtions are: sharp, prickly and stinging. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 10

Patient ID:	Response
01	Smooth
02	Bumpy
03	Rough
04	Slippery
05	Smooth
06	Rough
07	Gritty
08	Rough
09	Smooth
10	Slippery
11	Smooth
12	Rough
13	Smooth
14	Smooth
15	Rough

Table 19: Resistance at insertion

Commonly found words in describtions are: smooth, rough and slippery. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 11

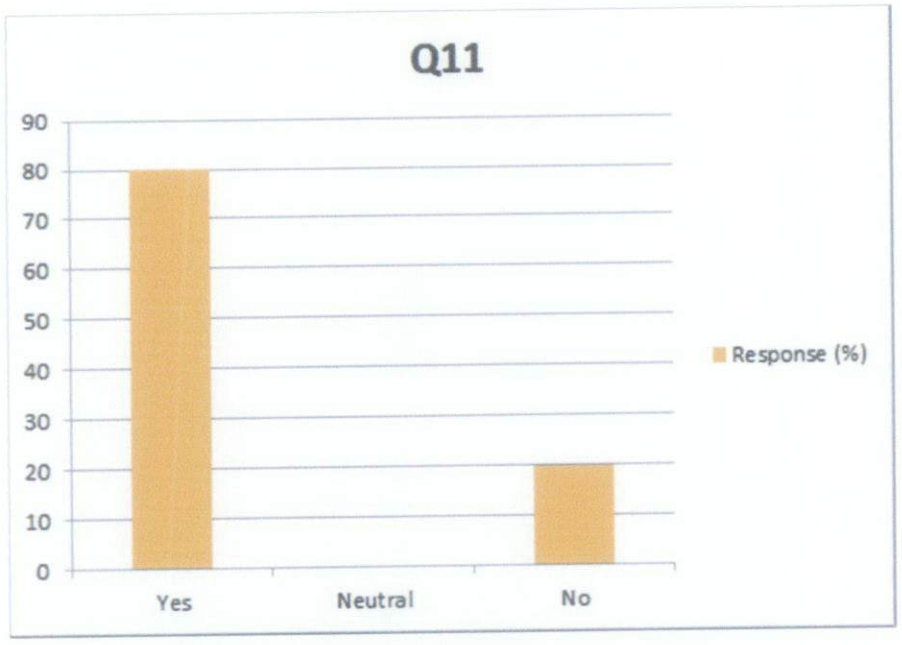


Figure 32: Pain felt during needle in skin

All the respondents except one patient agreed that they felt pain when the needle is in the skin. Though the feeling is just for a while and then it passes.

Question 12

Patient ID:	Response
01	Slightly Painful
02	Painful
03	Painful
04	-
05	Painful
06	Painful
07	Painful
08	Painful
09	Painful
10	-
11	Painful
12	Painful
13	-
14	Painful
15	Painful

Table 20: Degree of Pain at skin

Common pattern found in the responses is that patients view it painful. None said neutral. 3 patients responded not painful.

Question 13

Patient ID:	Response
01	Prickly like pouring spirit to wound
02	Poking like being pinched
03	Poking like wood splinter in skin
04	-
05	Poking like touching the end of the needle
06	Prickly like bugs crawling
07	Prickly like touching sand paper
08	Poking like touching sharp pebbles
09	Stinging like mosquito bite
10	-
11	Sharp like wood splinter in skin
12	Stinging like pinching skin using nails
13	-
14	Poking like wood splinter
15	Wood Splinter-Poking

Table 21: Description of pain sensation

Commonly found words in descriptions are: sharp, prickly, poking and stinging. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 14

Patient ID:	Response
01	Smooth
02	Rough
03	Gritty
04	Smooth
05	Smooth
06	Rough
07	Slippery
08	Rough
09	Gritty
10	Smooth
11	Rough
12	Rough
13	Smooth
14	Rough
15	Smooth

Table 22: Resistance at skin

Commonly found words in descriptions are: smooth, rough and slippery. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 15

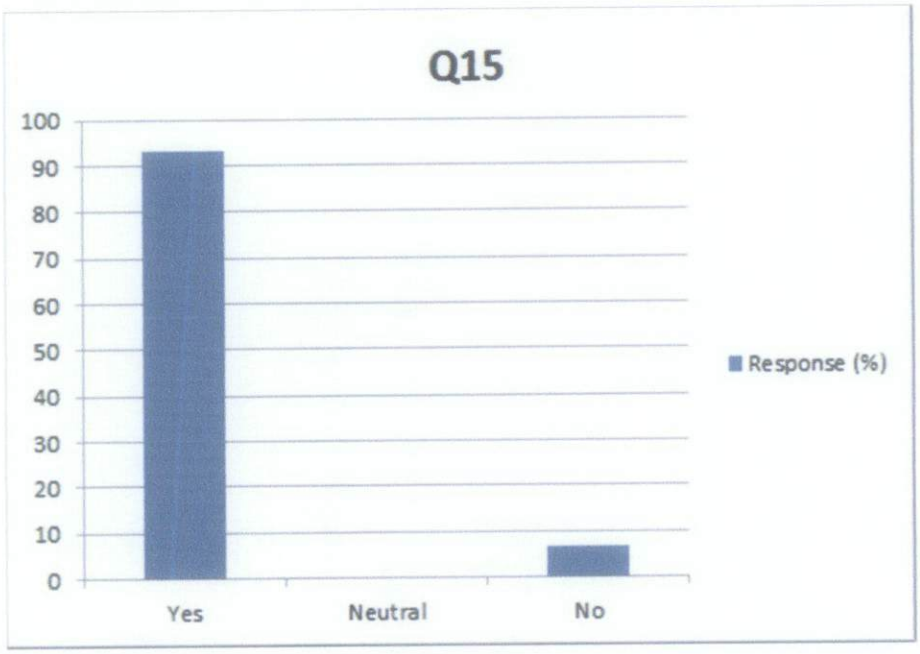


Figure 33: Pain felt during removal of needle

All the respondents except one patient agreed that they felt pain when the needle is in the skin. Though the feeling is just for a while and then it passes.

Question 16

Patient ID:	Response
01	Painful
02	Painful
03	Very Painful
04	Painful
05	Painful
06	Very Painful
07	Painful
08	Painful
09	Painful
10	Painful
11	Very Painful
12	Painful
13	-
14	Painful
15	Painful

Table 23: Pain degree at removal

Common pattern found in the responses is that patients view it painful and very painful. None said neutral. 1 patient responded not painful.

Question 17

Patient ID:	Response
01	Stinging like bee sting
02	Poking like pinched by someone
03	Stinging like ant bite
04	Poking like touching sharp stones
05	Poking like touching the end of the needle
06	Sharp like electrified
07	Prickly like touching sand paper
08	Sharp like stepping on glass pieces
09	Sharp like stepping on sharp pebbles
10	Prickly like spirit poured on skin
11	Stinging like crab pinch
12	Prickly like object taken out of wound
13	-
14	Sharp like pulling nail out of wound
15	Wood Splinter - Poking

Table 24: Description of pain sensation

Commonly found words in describtions are: sharp, prickly, poking and stinging. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 18

Patient ID:	Response
01	Sticky
02	Rough
03	Rough
04	Smooth
05	Slippery
06	Rough
07	Smooth
08	Coarse
09	Rough
10	Smooth
11	Slippery
12	Smooth
13	Smooth
14	Gritty
15	Smooth

Table 25: Resistance at removal

Commonly found words in describtions are: smooth, rough and slippery. Patients tend to describe the sensation felt similar to Minsky's theory.

Question 19

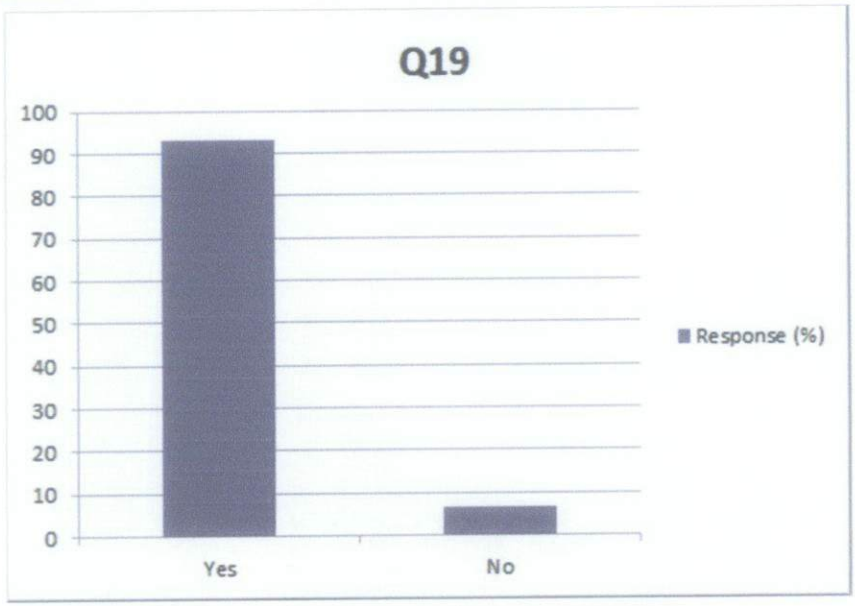


Figure 34: Level of fear after treatment

93.3 % of the respondents said that after the treatment, they didn't feel as much fear as before the treatment because they already felt what the pain was like. There was no more anxiety. And many agreed the pain prediction earlier was over-rated. Only one respondent still had fear after the treatment.

Question 20

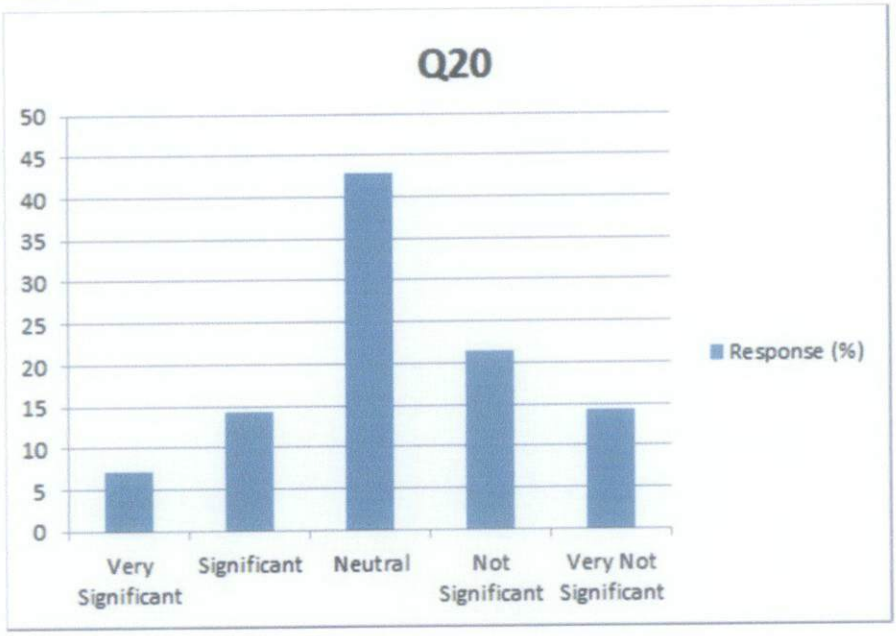


Figure 35: Significance the treatment played in reduction of phobia

The majority of the respondents were undecided whether the treatment played significance in reducing phobia towards needles and pain. Followed by 23.7 % of them saying it was not significant. The minority agreed that the treatment played a great role in reducing the phobia towards needles and pain.

Question 21

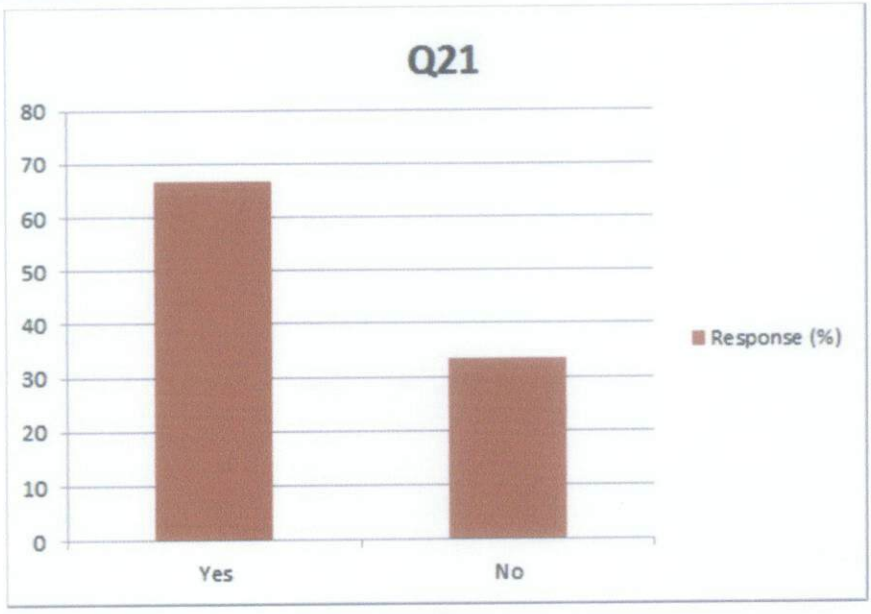


Figure 36: Taxonomy in helping to eliminated vagueness of pain sensation

More than half of the respondents agreed that a taxonomy will help in eliminating vagueness of pain sensation. It will also help to not over rate the sensation felt in the treatment.

From the survey results, it is evident that patients are afraid of needle piercing and pain inflicted from it. Patients tend to describe sensation by relating to real world experience. And some tend to over-rate their fear and also pain felt. There were also common vocabularies found which will be used to construct the 1st draft of the taxonomy. The taxonomy will be then validated through card sorting and also expert opinions.

4.3 Validation Exercise 1- Card Sorting Activity

Introduction

The aim of this section is to carry out a card sorting exercise to validate the 1st draft of the constructed taxonomy. It addresses the questions of the type of haptic sensations that patients perceive in an acupuncture treatment. This is motivated by the research findings in Study 2 which has highlighted that people tend to commonly describe the degree of pain and also sensation of pain. The questions to be answered are as follows:

Question 1: What are the dimension cues for pain inflicted properties?

Question 2: What are the dimension cues for sensation properties?

This chapter describes how the exploratory study was conducted. It suggests an approach that considers how to capture a relevant set of haptic cues as design requirements for constructing taxonomy to classify pain inflicted sensations. The approach involves utilization of patients' experience and perception in describing the degree of pain involved and also sensation involved in an acupuncture treatment. The chapter progresses by extracting the study findings and justifying the appropriateness of the potential cues suitable the finalized taxonomy.

Identification of Haptic Cues in the Real World Interaction

The objective of this section is to present a study that investigates the haptic sensations that patients recognize in an acupuncture treatment. It describes how an exploratory study is carried out and how the data analysis is performed in order to achieve the intended goal.

Motivations

This study is designed to identify dimension cues that are significant in the pain domain. The main objective of the study is to compile a structured vocabulary of patient's description when undergoing acupuncture treatment, focusing on the haptic sensation properties and pain inflicted properties of needle based treatments.

undergoing the treatment. From each set, the vocabulary that was used by the artist was identified. In this exercise, the way people describe sensation as reported in Minsky (1995) was observed. The vocabularies were examined to identify the terms used by each student across all the motion of insertion, needle at skin and removal. For example, the terminologies used by Student 1 to describe the sensation when undergoing the treatment included: "*stinging*", and "*very painful*" (needle insertion); "*poking*", and "slightly painful" (needle in skin); "slippery" and"*painful*" (needle removal); the same procedure was replicated to the rest of the data from all other students who took part in the study.

From the 15 sets of data, any similar terms were grouped under the same category, regardless of the needle size used. In this case, any descriptions of a particular sensation that involve the same terminology or similar expressions that is referring to the same concept are classified together. To demonstrate a simple example, the terms such as "*prickly like ant bite*", "*prickly like hot water splashing*", and *"prickly like bugs walking*", could be combined under a group heading called "prickly".

These terms identified were then cross examined with students all in one room. There were to throw out opinions during the categorization. They were cross-examined to assess consistency among them in describing the sensations involved in the treatment. No major inconsistencies were found. A similar approach to analyzing the haptic feedback perceived was taken for identifying the related pain inflicted cues.

Results

The data analysis has resulted in two inter-related sets of information on the sensation and pain inflicted properties. In this study, both sets of properties were classified and presented based on the description involved in the treatment.

The properties and features of the haptic cues found in this study are presented in Table 26-1. Three main types of interactions are identified, based on the actions made by the acupuncture doctor. The 'Insert needle' interaction occurred when the students described pain and sensation during insertion of the needle. The 'needle in skin' interaction occurred when the needle was in the skin of the students and they described how painful it was and also the sensation involved. The three types of haptic interactions are important because they could provide a basis to classify the specific haptic features in an acupuncture treatment.

TABLE 26-1: 1ST DRAFT OF THE TAXONOMY BEFORE CARD SORT

Type of Interaction	Action	Properties	Description
Needle and Skin	Insert Needle	Shape of Needle	Thin/ narrow
			Short/ Long
			Thick/ wide/ big
		Pain Inflicted	Painful
			No Pain
			Very Painful
			Unbearable
		Sensation	Prickly
			Stinging
			Poking
			Sharp
			Neutral
		Friction on insertion	Smooth
			Slippery
			Gritty/ sharp
			Coarse/rough

After Card Sort Activity

TABLE 27-1: PROPERTIES & FEATURES OF PAIN INFLICTED SENSATION (INSERTION)

Type of Interaction	Properties		
Insert Needle	Needle	Shape	Rounded
			Pointy
			Sharp
		Size	Short/long
			Narrow/wide
			Thin/thick
	Haptic Experience	Pain Inflicted with corresponding Sensation	
		Very Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Slightly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Alarmingly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
	Resistance on Insertion		Smooth
			Slippery
			Gritty
			Coarse
			Sticky

TABLE 27-2: PROPERTIES & FEATURES OF PAIN INFLICTED SENSATION (IN SKIN)

Type of Interaction	Properties		
	Haptic Experience	Pain Inflicted with corresponding Sensation	
		Very Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Slightly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Alarmingly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
	Resistance in Skin		Smooth
			Slippery
			Gritty
			Coarse
			Sticky

TABLE 27-3: PROPERTIES & FEATURES OF PAIN INFLICTED SENSATION (AT REMOVAL)

Type of Interaction	Properties		
	Haptic Experience	Pain Inflicted with corresponding Sensation	
		Very Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Slightly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
		Alarmingly Painful	Prickly
			Stinging
			Poking
			Sharp
			Bumpy
	Resistance at removal		Smooth
			Slippery
			Gritty
			Coarse
			Sticky

From Table 26-1, the property "needle", relates to the first type of interaction in which the haptic experience involves the skin and the tool here "needle". The needle can vary according to shapes: "rounded, pointy and sharp". The needle can also vary according to size: short/long, narrow/wide, thin/thick. These properties which are associated to the tool used in acupuncture were noted by the students during the study. For the haptic experience property, the students commented on the pain inflicted versus the sensation. They commented that these terms should correspond and not stand alone. As an example, when describing the degree very painful, 1 student said that it is 'stingingly very painful'. The same degree was described by 2 other students

as 'sharply very painful'. In the round-table discussion, 4 out of 5 students highlighted that the degree of pain inflicted has to correspond to the haptic sensation involved to give a clearer picture to the classification.

The second type of interaction involved needle remaining in the skin. The students suggested that the property needle is no longer needed in the 2nd table as contact has already been made with the skin. They are much concerned with the pain felt and sensation involved during the needle's existence inside the skin. All of the students argued that the term 'Slightly Painful should be added to the table' as most of them used the term during description and it wasn't available in the 1st draft of the classification. Furthermore, 9 out of the 15 students justified that the term 'Neutral' should be removed from the classification of pain as when pain is felt, there is no room for neutrality unless there is something wrong with the respondent's pain receptors. So they suggested it will be appropriated to replace 'Neutral' with 'Slightly Painful'. When describing the sensation involved in needle in skin, students generally said 'Slightly Painful and bumpy like touching splintered woods'. Most of them answered slipper and smooth for the resistance when needle is in the skin.

The third type of interaction involved the removal of needle from the skin. The student also raised the concerned that the property needle should not exist in this table too with the same justification as above. 8 out of 15 students argued that on the section Resistance on insertion the term 'Sticky' should be added. They perceive removal of the needle sticky as they can feel the walls of their skin interacting with the needle at removal.

During the round-table exercise, students were provided with cue cards which they had to stick on the white-board to the corresponding categories. During this exercise, there weren't many inconsistencies as students agreed on most of the labelling. Yet the structure of the table was modified to make room for their suggestions especially on the part where pain degree has to correspond with the haptic sensation felt. So adjustments were made on that part and the card sorting activity proceeded.

Important points that were raised during card sorting activity:

- The pain degree and haptic sensation should co-exist
- The term neutral should be removed.
- The property needle should only exist in insertion interaction
- Needle property should have two distinguished labels: Shape & Size
- The word bumpy should be added to the category haptic sensation
- The word sticky should be added to the category resistance.
- In the pain degree: - Add 'Slightly Painful', remove 'Neutral' and replace 'Unbearable' with 'Alarmingly Painful'

The outcome of the card sorting activity was an enhanced taxonomy, which was finalized for review from the experts.

4.4 Validation Exercise 2 – Expert Opinion and Interview

A short interview was conducted to validate finding from Study 2 and Card Sorting activity. The interview was carried out on Dr SS Jayabalan, a certified doctor in alternative medicine and acupuncture (T.C.M.). The objective of this interview was to further enhance the taxonomy by getting expert input on how to improve the finalized taxonomy. The interview was tape recorded and no video recording was done.

Background of Acupuncture Doctor:

Figure 37: Acupuncture Clinic information.

Dr SS Jayabalan is a certified Acupuncture doctor who has acquired his doctorate in traditional healing at Sri Lanka and also India. He has been practising acupuncture in Malaysia for more than 10 years and is part of Malaysian traditional healers convention.

He also specializes in other healing techniques such as the Japanese based REIKI and Rebirthing (Mastership in both) [36].

Figure 38: Acupuncture Clinic illustration.

Figure 39: Inside the Clinic

He gave us the consent to carry out studies at his clinic on his patients while he conducted the treatments on them. Also he agreed to facilitate us during the card sorting activity by demonstrating the treatment to the 5 card sorting participants involved in the validation exercise 1.

When asked on his input on our findings in the study. He agreed to most of the statements, yet he had certain concerns pertaining to the study. He agreed to

the properties of the needles, whereby indeed there were different types and shapes of needles. Yet mainly involved, short/long, thick/think/, wide/narrow variations. He added that, we can also add their physical properties to further classify them by that won't be needed in this study according to him.

Apart from that, he raised his concern that the degree of pain varies depending on the areas being pierced. For instance, it is much more painful piercing the pinkie toe comparatively to to piercing a person's foot. To address that concern, we have taken it into consideration and set that for this study, the area in which the piercing was done was the ones with common threshold of pain like the cheeks, hands and leg.

Furthermore he addressed the concern of varying degree of pain when a person has swollen body parts. He says that, when a person is sick or their body parts aren't functioning well, the pain level is much higher than normal people. So we have to take that into account. But for this study's purpose, all the subjects interviewed were people of fairly good body condition, according to his observation. So he was fine with it.

He also added that, we have to take note that acupuncture doctors normally pinch the patients at the point they will be piercing to reduce the impact of the needle itself. So the pain felts comes 30 % from the pinching.

We also clarified other concerns by asking him questions on the structure of the taxonomy and its contents. He was 90% satisfied with the outcome.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The main motivation for this paper is the practice of acupuncture. Acupuncture doctors face the problem of attracting clients though they have great skills in the field due to clients phobia towards needles. This paper reveals the key issues in the existing approach of describing pain sensation. The problem identified was that pain is an abstract sensation and it is hard to describe. The vagueness of the sensation makes it tough to be classified. Pain has never been classified under haptic studies. It is also found that people are generally phobic towards needle inflicted pain sensation. This hinders them from taking any treatment related to piercing though it proves to be beneficial and effective. So this paper proposed a study to classify needle inflicted pain sensation in a taxonomy.

Various studies were carried out to analyse how people describe pain sensation. Studies were also done on haptic approach of describing sensation mainly under Minsky's (1995) works. Surveys were done and interviews were executed at an acupuncture clinic to collect data on how patients react to and describe the pain sensations involved in the treatment. These data were then used to construct a preliminary taxonomy that was validated using card sorting activity and expert opinions.

As conclusion, the taxonomy constructed will help shed greater light to the problem of describing pain sensation by eliminating the vagueness that existed. The taxonomy will be a base-line to future researches and system developments under haptic studies for the area of pain related phobia reduction. Furthermore, the study will become a ground-breaker in the in haptic and touch technology to be the first to explore into classifying needle inflicted pain sensation. With the motivation that this study will be a baseline for future development in the area of pain related phobia reduction under haptics and also virtual reality.

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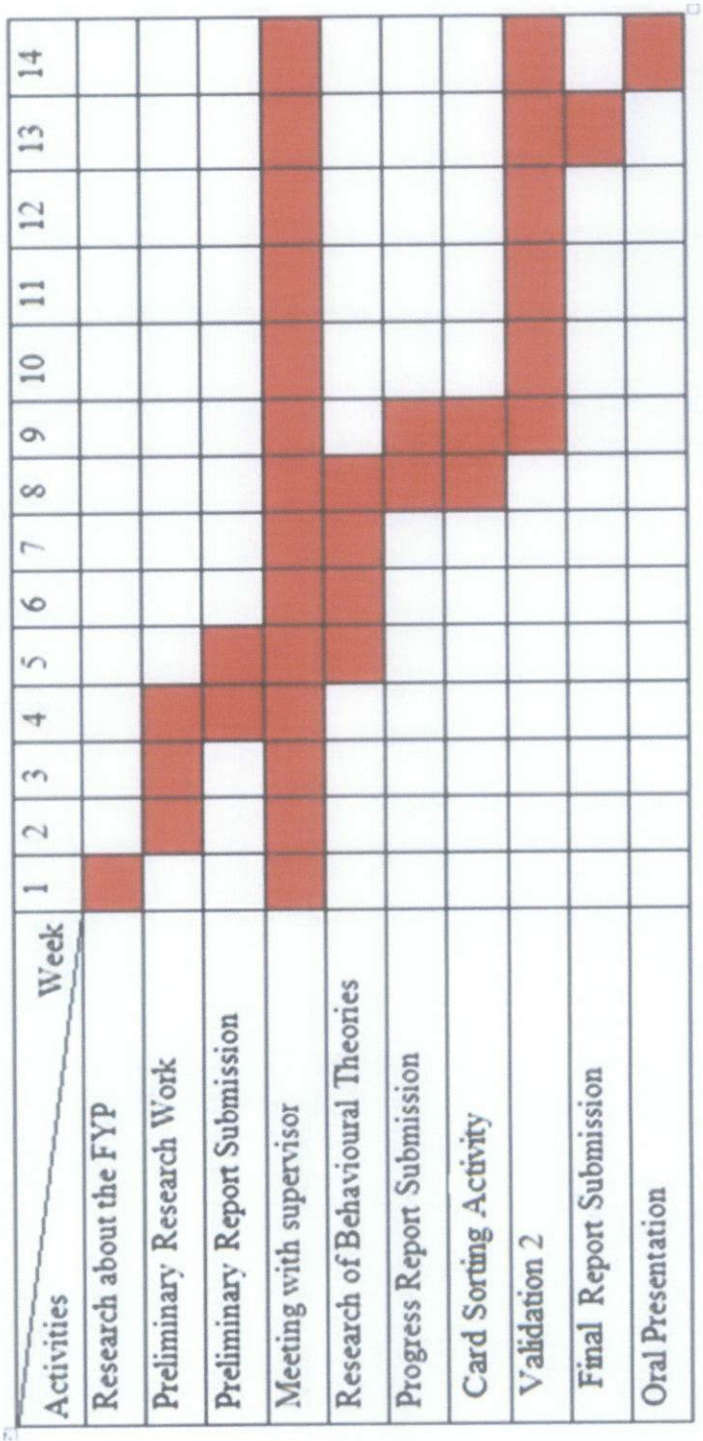
APPENDICES

Appendix A-**Gantt Chart**



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Identification Number for this test:

CONSENT FORM

Title of Study: Pain Taxonomy – Classifying Needle Inflicted Pain Sensation

Please tick box

1. I confirm that I have read and understood the information sheet dated..... for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐

3. I agree to take part in the above study. ☐

Interviewee name	Date	Signature
Researcher	Date	Signature

Patient ID:

7. If yes, how severe?

Very Significant	
Significant	
Neutral	
Not Significant	
Very Not Significant	

8. If yes, describe the degree of pain involved.

_____

9. Describe the sensation to a familiar experience before this.

_____

10. What is the resistance level of the needle during insertion/ how does it feel like (E.g: rough)?

_____

11. When the needle is in your skin do you feel any pain?

Yes	
No	
Neutral	

12. If yes, describe the degree of pain involved.

_____

13. Compare the sensation to a familiar experience before this.

_____

14. What is the resistance level of the needle at your skin?

_____

15. When the needle is removed, do you feel any pain?

Yes	
No	
Neutral	

16. If yes, describe the degree of pain involved.

_____

Patient ID: 13

Please fill in the blanks or mark ☑ where appropriate.

1. Are you afraid of acupuncture treatment?

Yes	✓
No	

2. If yes why?

First timer

3. What made you want to take this treatment?

Best available alternative	✓
Trust towards the practitioner	
For the sake of trying	

Others please specify: _____

**** **Patients answer aloud** **********

4. At insertion of the needle please describe the shape of the needle.

Width: Fat

Length: Long

Size: Thick

5. **Does the shape of the needle influence your fear towards the treatment?**

Yes	✓
No	
Neutral	

6. **Does the shape of the needle influence the degree of pain during insertion?**

Yes	✓
No	
Neutral	

Patient ID:

17. Compare the sensation to a familiar experience before this.

_____

18. What is the resistance level of the needle at your skin?

_____

19. After the treatment, has your fear towards the treatment reduced?

Yes	
No	

20. If yes, how significantly has it reduced?

Very Significant	
Significant	
Neutral	
Not Significant	
Very Not Significant	

21. In your opinion, if there were to be a system to simulate the pain involved in this treatment, will it help reduce the fear you current have or had?

Yes	
No	

Thank you for attempting the questionnaire